EDISON
Electric Institute
BULLETIN

AUGUST, 1935

STATISTICAL DATA OF THE ELECTRIC LIGHT AND POWER INDUSTRY

Compiled Monthly by the Edison Electric Institute—Covers 100% of the Industry

DURING THE MONTH OF MAY (Preliminary Report)—For June, see page 374

	1935	1934	%
Kilowatt-hours Generated* (net)			
By Fuel	4,000,670,000	4,201,929,000	− 4.8
By Water Power	3,457,810,000	2,876,864,000	+20.2
Total Kilowatt-hours Generated	7,458,480,000	7,078,793,000	+ 5.4
Additions to Supply			
Energy Purchased from Other Sources	177,693,000	254,255,000	−30.1
Net International Imports	64,575,000	79,856,000	−19.1
Total	242,268,000	334,111,000	−27.5
Deductions from Supply			
Energy Used in Electric Railway Departments	44,530,000	50,512,000	−11.8
Energy Used in Electric and Other Departments	111,373,000	112,660,000	− 1.1
Total	155,903,000	163,172,000	− 4.5
Total Energy for Distribution	**7,544,845,000**	**7,249,732,000**	**+ 4.1**
Energy Lost in Transmission, Distribution, etc.	**1,400,065,000**	**1,333,079,000**	**+ 5.0**
Kilowatt-hours Sold to Ultimate Consumers	**6,144,780,000**	**5,916,653,000**	**+ 3.9**
Sales to Ultimate Consumers (kw-hrs)			
Domestic Service	1,060,451,000	966,522,000	+ 9.7
Commercial—Small Light and Power (Retail)	1,098,782,000	1,034,710,000	+ 6.2
Commercial—Large Light and Power (Wholesale)	3,345,688,000	3,293,370,000	+ 1.6
Municipal Street Lighting	174,998,000	167,927,000	+ 4.2
Railroads—Street and Interurban	353,863,000	349,199,000	+ 1.3
Railroads—Electrified Steam	65,792,000	57,298,000	+14.8
Municipal and Miscellaneous	45,206,000	47,627,000	− 5.1
Total Sales to Ultimate Consumers	6,144,780,000	5,916,653,000	+ 3.9
Total Revenue from Ultimate Consumers	$153,202,700	$147,915,400	+ 3.6

DURING TWELVE MONTHS ENDING MAY 31st

Kilowatt-hours Generated* (net)			
By Fuel	53,301,602,000	51,518,260,000	+ 3.5
By Water Power	33,433,175,000	31,199,434,000	+ 7.2
Total Kilowatt-hours Generated	86,734,777,000	82,717,694,000	+ 4.9
Purchased Energy (net)	2,876,524,000	3,366,852,000	−14.6
Energy Used in Electric Railway and Other Departments	1,974,431,000	1,965,130,000	+ 0.5
Total Energy for Distribution	**87,636,870,000**	**84,119,416,000**	**+ 4.2**
Energy Lost in Transmission, Distribution, etc.	**14,972,907,000**	**14,635,996,000**	**+ 2.3**
Kilowatt-hours Sold to Ultimate Consumers	**72,663,963,000**	**69,483,420,000**	**+ 4.6**
Total Revenue from Ultimate Consumers	**$1,870,323,500**	**$1,801,656,100**	**+ 3.8**
Important Factors			
Percent of Energy Generated by Waterpower	38.5%	37.7%	
Average Pounds of Coal per Kilowatt-hours	1.44#	1.45#	
Domestic Service (Residential Use)			
Average Annual Consumption per Customer (kw-hr)	646	612	+ 5.6
Average Revenue per kw-hr (Cents)	5.22¢	5.41¢	− 3.5
Average Monthly Bill per Domestic Customer	$2.81	$2.76	+ 1.8

BASIC INFORMATION AS OF MAY 31st

Generating Capacity (kw)—Steam	23,740,400	23,980,900	
—Waterpower	8,949,900	9,001,200	
—Internal Combustion	500,800	470,100	
Total Generating Capacity in Kilowatts	33,191,100	33,452,200	
Number of Customers			
Farms in Eastern Area (Included with Domestic)	(538,786)	(510,142)	
Farms in Western Area (Included with Commercial—Large)	(212,134)	(208,594)	
Domestic Service	20,653,652	20,196,207	
Commercial—Small Light and Power	3,736,936	3,697,715	
Commercial—Large Light and Power	499,583	524,945	
Other Ultimate Consumers	71,102	67,606	
Total Ultimate Consumers	24,961,273	24,486,473	

* By courtesy of the U. S. Geological Survey with deductions for certain plants not considered Electric Light and Power Enterprises.

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EDISON ELECTRIC INSTITUTE BULLETIN

Volume III AUGUST, 1935 No. 8

Statement by President McCarter on Certain Expenditures and Actions of the Edison Electric Institute

The Case of Ashwander vs. Tennessee Valley Authority — The Wheeler-Rayburn Bill

Mr. Thomas N. McCarter, President of the Edison Electric Institute, by authority of the Board of Trustees thereof, issued the following statement on July 23:

FOR a year or more the electric industry has been subjected to a most extensive political and governmental attack. This has manifested itself in many different ways, the three most important of which are direct governmental competition, in the ultimate development of which plan the government expects to spend a total of $2,700,000,000; loans and grants by the government to municipalities for the construction of plants in competition with existing facilities which have been freely made; and the attempt to abolish holding companies.

The Edison Electric Institute is not a political organization. It is the trade association of the industry. It is a research and fact-finding body existing for the information it can render to its membership. When, however, the crisis above described became apparent, believing that the whole plan of the government was unconstitutional and *ultra vires*, it determined that it owed to its membership the obligation to test out these principles of constitutional law. It therefore authorized the employment of the Honorable Newton D. Baker and the Honorable James M. Beck, constitutional lawyers of national reputation, to pass upon the constitutionality of the proposed governmental projects, such as that inaugurated in the Tennessee Valley, and of governmental loans and grants to municipalities for the purposes above set forth. These gentlemen united in a joint opinion that both of such activities on the part of the Government were beyond the power of Congress to authorize, and were unconstitutional. The cost of these opinions to the Institute was $35,000, plus the incidental expenses of the two lawyers rendering the same.

Thus fortified, the Institute decided to act and to participate in the expense of the litigation necessary to determine the matters above referred to. In this connection, it has paid $50,000 to the firm of Cabaniss & Johnston of Birmingham, Alabama, attorneys of record in the case of Ashwander vs. Tennessee Valley Authority, and also expended $1,992.29 in connection with the reporting of that case. It proposes further to participate in the cost of appealing this case to the Supreme Court of the United States so that a final judicial determination of the constitutional right of the Federal Government to expend its taxpayers' money in the destruction of the property of its taxpayers may be obtained, both as respects direct competition by the Government, and loans and grants to municipalities for the purpose of achieving a like result.

In connection with the Wheeler-Rayburn Bill, the Board of Trustees in February adopted a resolution recommending that each company should present its own case on the Wheeler-Rayburn Bill, and that the Edison Electric Institute should answer inquiries and furnish facts to member companies relating to the matter as might be desirable. The matter of generally conducting the opposition to the bill was left to the Committee of Public Utility Executives, of which Mr. Philip H. Gadsden is chairman. In order to aid this committee in its work, the Institute later paid the law firms of Simpson, Thacher & Bartlett and Sullivan & Cromwell the sum of $75,000 each for their legal work rendered to the Committee of Public Utility Executives in connection with the proposed legislation. In addition thereto, the Institute has spent $19,757.47 for official copies of transcript and government documents, printing, mimeographing and postage. All such expenditures have been audited by Price, Waterhouse & Company and the audit delivered to investigators of the Senate Investigating Committee, together with correspondence, letters, records and material relating to the bill.

The Associated Gas & Electric Company is not a member of the Edison Electric Institute. The policy which certain representatives of that company are alleged to have pursued does not meet with the approval of the Institute. It has been the aim and policy of the Institute that the whole opposition to these governmental activities and to this legislation which collectively threatened the very life of the industry should be carried on in an open and above-board manner.

THE PRICE, TO THE TYPICAL SMALL CONSUMER, OF ELECTRICITY IN MUNICIPAL PLANTS

Net cost per kwhr in 1680 places served by municipal plants, for domestic electric consumers using 25 kwhr per month, as reported by the Electric Rate Survey of the Federal Power Commission. Each dot represents a location; the circles are places supplied with energy from TVA sources. Ten cents per kwhr represents the most popular choice, regardless of size, with eight cents a close second. The average place supplied by a municipal plant has a population of about 2000 and a rate of a little over 8 cents. In order to save space, four cities with populations above 125,000 have been omitted (Columbus 4c, Seattle 5.6c, Cleveland 3.5c and Los Angeles 4.8c).

This Matter of Donations to Charitable Funds

By Preston S. Arkwright
President, Georgia Power Company

A statement made by Mr. Arkwright on July 24, 1935

IN his press conference at Washington today (July 24), President Roosevelt made objections to donations to charitable funds by corporations, and urged enactment of a law which would effectively block all such contributions by putting a tax on them. In his statement he referred to a conversation he had had with "the president of a public utility company in a Southern state" on the subject of such donations.

I do not know that Mr. Roosevelt's statements refer to me, but I believe they do. I had such a conversation with him, and the Georgia Power Company does make numerous contributions to charitable, civic and general welfare funds and agencies.

Most certainly, we do not make such contributions for the purpose stated by Mr. Roosevelt—to "buy up good will." I made no statement of this kind to Mr. Roosevelt in our conversation. Neither is it our policy to subscribe to every "chicken dinner" in the state.

A corporation can't buy up the good will of the public, any more than an individual can. Good will can't be bought. It can be gained only by deserving it. The Georgia Power Company earnestly desires the good will of the public, and it strives to gain it by deserving it.

We seek to gain good will by giving good service to our customers, by low rates, by considerate treatment, and by living up to our company slogan, "A Citizen Wherever We Serve."

As a part of our citizenship, it is not only our privilege, but it is our duty to assist, financially and otherwise, in any movement for the general welfare of the community. If tuberculosis can be prevented, if illiteracy can be reduced, if epidemics can be checked, if educational opportunities can be increased, if poverty and human suffering can be relieved, if industrial development can be stimulated and opportunities for jobs thereby increased, if the community can be made a better place to live in, every person and every business in the community benefits. It is, therefore, the duty of every person and every business in the community to contribute money, or personal work, or both, for the support of the charitable and other agencies that bring about these improvements. The Georgia Power Company would be negligent of its duty and a most unworthy citizen, if we were willing to accept all such community benefits without contributing anything toward making them possible.

Briefly, our company policy is that if a movement is for the general welfare and if it has the general support of the public, this company will do its part. Not only has our company followed this policy but, as a solicitor in public fund-raising campaigns, I have urged this policy upon other corporations. It is the only proper attitude that can be taken by any business worthy of a place in the community. Whether we or any other corporation gains good will by it, I do not know. I often doubt it. But we intend to continue this policy, as a duty and as a civic obligation, unless we are prevented from doing so by the law Mr. Roosevelt proposes.

If this law should pass and if we and all other corporations should be compelled to discontinue our contributions to such funds, I do not believe there is a single charitable or similar agency in Atlanta or elsewhere in Georgia that could survive.

It might be of interest to recount the circumstances of my conversation with Mr. Roosevelt. It occurred in 1930, when he was Governor of New York, and shortly after he had taken over the Meriwether Foundation at Warm Springs, Ga. At Mr. Roosevelt's invitation, I called on him at Warm Springs to discuss with him the matter of electric service at the Foundation.

Mr. Roosevelt stated that the Foundation was a charitable organization chartered under the laws of New York, and asked if we would not give the Foundation a special rate on its electricity, lower than the usual rate, because of the charitable nature of the institution. I told him we could not do this, that our rates were required by law to be uniform to all customers.

We then discussed the matter of putting in order the electric distribution system at the Foundation. It was in bad condition, and it was estimated that about $6,000 would be required to rehabilitate it. I told Mr. Roosevelt that, while we could not give the Foundation a special electric rate, we could make a donation to the Foundation, and that we would donate the amount necessary to put the distribution system in order. It was then that we got into a discussion of the Georgia Power Company's policies on the matter of public donations. I told him that because of the charitable nature of the Foundation, and because of the benefit which all of Georgia would derive by reason of its development and expansion, I felt that the company would be thoroughly justified in making the donation. Mr. Roosevelt did not accept the outright donation. Instead, we agreed upon an arrangement whereby he deeded the Foundation's electric distribution system to our company without cost. As a result, the company stood the expense of rehabilitation and, in addition, the Foundation was saved the loss it had previously incurred in operating the distribution system.

These circumstances are not recited in any criticism of Mr. Roosevelt. They do, however, provide an illustration of the type of worthy causes to which many of our contributions have been made. They also, in light of Mr. Roosevelt's statements today, provide an illustration of the fact that, quite often, good will is not gained by our efforts to assist worthwhile agencies.

After the meeting of the United States Chamber of Commerce in Washington this spring, Mr. Roosevelt spoke sarcastically of that organization because he said that its members had completely ignored "the human element" and had displayed complete indifference to human welfare. The truth is that business organizations are the largest contributors to human welfare, directly in the wages they pay, and indirectly in their taxes and their contributions to charitable and similar agencies. If Mr. Roosevelt's present viewpoint should prevail and if the new law he proposes should be enacted, it would be one of the most serious blows ever struck at efforts to advance human welfare, for it would wipe out of existence thousands of privately supported charitable and welfare agencies throughout the country.

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Accident Prevention, an Important Part of Management

By J. P. McCann

Safety Manager, New England Power Engineering & Service Corpn.

Eighth of a series of articles sponsored by the Accident Prevention Committee, W. A. Buchanan, Chairman

THE electric light and power industry has long been active in the field of accident prevention. Dealing with high voltages and concentrated power production which, unless safeguarded, involve serious accident hazard, we have developed remarkably safe practices and technique. We have had to study the principles of safety as well as its art.

The public utility executive is concerned with safe operation of his utility, whatever it may be, because safe operation is economical and effective operation.

Safety is not something superimposed upon an organization—it is an integral part of its operations.

Accidents are not a necessary evil in or by-product of a business. They, to a large extent, indicate lack of planning, supervision or discipline.

Excessive accidents are an indication of a lack somewhere in the management. We have to conduct our business with the aid of average individuals, not paragons. They do not wish accidents to happen, quite the contrary. There is every reason why they wish to BE and to FEEL safe in performing their tasks. In other words, there is in every normal employee a motive or incentive pointing, if not acting, in the direction of safety. Nobody wishes to suffer pain and to impair his ability to work or play. Neither does he wish such impairment to come to others. Why then is he not more careful? That is for management to determine.

If we are right in our conviction that a normal employee would like to see fewer accidents, then management has a potent force which only needs direction and organization to become effective.

When preventable accidents occur they do so because one or more persons have for the time being allowed influences stronger than their natural desires for safety to overcome that desire. The purpose of the many effective means in accident-prevention campaigns is to remove such inhibitions. The most permanently effective of these means are education and training. A dramatic appeal produces results and such appeals should be used. But, after all, the individual's habits must be safe ones and these are formed, bit by bit, by the educational process.

Safe habits are, after all, the basis of safe practice. And a large majority of employees have formed safe habits. The unsafe employees, as a rule, have drifted into unsafe habits. This fact is illustrated by the probability that an employee who is involved in an excessive number of accidents in one year has had a poor safety record in earlier years. When we read of a fatal automobile accident on the highway we are likely to learn that the driver has had previous, and possibly numerous, less severe accidents. The so-called "accident-proneness" is generally due to careless habits.

And yet lack of appreciation and application of the principle is back of all preventable accidents.

If we find a piece of machinery heating up or otherwise not performing normally we sense trouble somewhere. Possibly we pour cold water on a bearing to prevent it from melting out but this is only a superficial expedient. We look for the source of friction, so with accidents. Too many accidents indicate internal trouble. It may be mechanical but it is probably human. Shocking the workers by arousing fear may be necessary to bring quick results, but the real source of the hazard must be located and removed before permanent improvement is possible.

In considering the relation of management to accident reduction we naturally begin with employee accidents as these are most nearly under management control. Accident statistics of recent years show that management has been successfully attacking this problem. There are several incentives to this. One is a realization of the fact that unsafe conditions indicate poor management. In addition, state compensation laws have fostered safe practices and working conditions. Recent economic conditions have stimulated waste reduction at this point as well as others.

The total of 104,000 accidental deaths last year in this country is a staggering one. A large number of these could have been prevented. Of the nearly 10,000,000 non-fatal accidents only a small part were inevitable. Experience shows that where education, engineering and sane public control unite to reduce accidents they achieve results. More than two-thirds of the fatalities, however, occur in the home and on the highways, about one-third each. These are the fields most difficult to cultivate.

While it would be premature to say that the employee accident situation is satisfactory there is no doubt that it is well in hand. The individual efforts of corporations and other organizations, aided by their collective activities in trade and technical societies, have pointed the way to reasonably safe operating procedure.

But the safety responsibility of corporation management extends beyond their immediate field. Their employees in large numbers use the highways in the performance of duty.

In addition, management should also be concerned with off-duty accidents to employees and with accidents to employees' families. Management has a great opportunity through its employees to reduce greatly both highway and home accidents.

It needs no argument to prove that an employee living in a safe home is a more care-free and therefore more reliable and safe employee on the job than one in whose home safety is disregarded.

Regulation by Accounting—An Innovation

By Park Chamberlain
United Light & Power Company, Chicago, Ill.

An address before the Illinois Public Utilities Association

FACED at every hand with serious dangers—economic, financial and political—and girded for a fight to the death, it is not strange that little present thought is being given by utility managers to an insidious attack from a quarter apparently no more formidable than an accountant's desk.

Accounting, in its modern concept, is the art of accurately recording the financial transactions of a business enterprise and correctly portraying its investment in property, its equities and its income. It is essentially factual. It is a friend, not a foe, to business.

Consequently, when a new system of accounts is proposed, which adds refinements to a former satisfactory system, the manager is apt to shrug his shoulders and dismiss it from his thought as one more unnecessary, expensive annoyance to be put up with, but nothing more serious. He little dreams that there may be concealed within the system provisions which defeat the very purpose of accounting; which prevent a reflection of the true income, as well as of the actual investment in property; which deprive the owner of his property, his constitutional rights, and almost the last vestige of his managerial power.

Every decade brings on its horde of reformers, and this one has been no exception. As you all know, we have of late been entertained by a relatively small coterie of men connected with the utility commissions of certain of our states, seriously and rather fanatically working together in a joint effort to devise methods which would put the utilities more effectually under their control. They have originated radical measures by the score and have succeeded in getting them before the legislatures of their states. In some measure they have been successful, but for the most part they have found it difficult to inoculate the legislators with their own distrust and suspicions. Tempered with intelligent business judgment, their own bills came out quite unrecognizable and ineffective for their radical purposes. In their eagerness to rule, all laws became to them inflexible and futile. Not only did they lack the desired force as weapons, but, curiously, they were found to be a curb on the powers of these self-appointed crusaders. Thwarted by constitutional limitations; disappointed by judicial decisions running counter to their own thought; unable to obtain legislation satisfactory for their purposes; yet undaunted, they sought methods yet more subtle and refined.

Neither Incredible Nor Impossible

Tired and disgruntled from their failure to obtain effective legislation, and spurred on by zeal, as well as defeat, these men are seeking to read into uniform accounting statutes the power to regulate through requirements in respect to the method of carrying accounts. It may not seem clear to you, at the moment, how this can be done. Yet if this system of accounts stands, they will have accomplished exactly that effect. We must not lull ourselves into a sense of security in thinking that it is either incredible or impossible. It is but a few short weeks back that the Chief Justice of the Supreme Court of the United States, in rendering an opinion upon the constitutionality of one of the recent moratorium laws, found in our Federal Constitution powers hitherto deftly concealed and never before exercised, and, in words now historic, he said, "While emergency does not create power, emergency may furnish the occasion for the exercise of power."

The fact that powers actually granted by a statute have not been heretofore used is not an argument in favor of the construction of the statute in a manner to deny such powers. And whether the courts will construe these uniform accounting statutes in the manner now suggested remains yet to be seen, but in the present emergency, with apparent ill-feeling running so high against utilities, we may expect a worthy encounter and one not without its dangers.

Before passing to the innovations contained in this system of accounts, it may be of interest to some of you who have not followed the accounting side to know that about two years ago the Public Service Commission of Wisconsin, through its accounting section, proposed a new system of accounts. Whether this had been prepared in cooperation with those working on the New York system, which was being prepared under the direction of Dr. Maltbie, I am not informed. It was at least contemporary. It is quite possible that late in 1931, when the Wisconsin Commission adopted a partial revision of their system of accounts for electric utilities, it was a step in advance of the New York theorists.

At that time the Wisconsin Commission inserted in their system of accounts, as a sub-account under "Fixed Capital," what is described as the "Fixed Capital Purchase Adjustment Account." This was not made retroactive and provided that there should be included in this account the difference between (1) the amount approved by the Public Service Commission for the purchase of any utility plant consisting of an operating unit or system, and (2) the *actual original cost* of constructing and installing such plant, *less the amount standing in the depreciation or retirement reserve or any similar reserves and accounts of the vendor.*

An Accounting "First Appearance"

This seems to be the first appearance in a uniform system of accounts of a requirement that utility property be stated in the accounts at *original cost to the company first installing the property,* and that the depreciation reserve accrued by a selling utility prior to the sale should become in effect an encumbrance upon property sold to another utility and prevent the accrual of depreciation charges based upon its present worth.

The proposed system of accounts follows very closely the design of the New York systems for gas and electric companies, made effective in 1934, and for the telephone companies, made effective in 1935. It is based upon the same general principles, but had added a multitude of refinements, all designed to detract from the earnings of the utility. It is a model of the chiseler's art throughout. Whether this system, as

prepared, lacks finesse, or whether the purpose of the author was to step out in the open and present his theories fairly for legal determination, I am unable to decide. Suffice to say that, whether wittingly or not, he has done the latter and that is to his credit.

It is not a secret that the system is to be presented this fall to the National Association of Public Utility Commissioners by their Accounting and Statistical Committee, with view to obtaining its universal adoption throughout the states. For this reason the matter is or will probably soon be a live issue with your association.

Within a limited time it is possible to touch but briefly on the major principles which are fundamentally opposed to our laws and to commonly accepted utility practices. It would literally take hours to list and mention the multitude of changes in minor matters. And I should say before passing that one of the most notable things is the continual requirement that before doing this act or that the permission of the Commission must be obtained. Again, various acts may be done "only upon the order of" the Commission, or may not be done "except as authorized" by the Commission. In many of its provisions it entails complete administrative control by the Commission, and to an extent clearly contrary to law. There is also a tremendous addition to the accounting in the way of new accounts, but more from clearing accounts.

Original Cost

Perhaps the most striking innovation, in view of the decisions of the United States Supreme Court, though not the most burdensome in accounting, is that requiring fixed capital accounts to be rewritten, and thereafter maintained, on the basis of original cost. You will assume at once that this means cost to the accounting company, but that is far from correct. Original cost, as used in this new system of accounts, is defined as the actual money cost of the property *at the time when it was first devoted to the public service, whether by the accounting company or by a predecessor public utility*. This principle, which is also adopted in the New York classification, has been aptly described as "aboriginal cost." Neither the system of accounts, nor the order putting it into effect, in New York State, indicates the reasons for restating fixed capital values to reflect original cost. No order has, of course, been prepared or publicly submitted in Wisconsin, but if it follows the form of order entered in New York, it will contain a statement that "in prescribing this system of accounts, the Commission does not commit itself to the approval or acceptance of any item set out in any account, for the purpose of fixing rates or in determining other matters before the Commission," and that the Commission will determine from time to time just what consideration shall be given to the various items. This is a matter of finesse, designed to protect the system from attack on the ground that original cost is to be used as the basis for rate making, although the Commission has, in fact, no other thought or purpose. And, indeed, the expense necessary to rewrite these accounts, to say nothing of the danger of inaccuracy in estimates where original cost cannot be obtained, amounts to much more than any advantage to be gained through such a subdivision, except it be used for rate-making purposes. From decisions of the Wisconsin Commission we are frankly apprised that they consider original cost the proper rate base, and I think the same feeling can be noted in the New York decisions, though that commission has been held in line by decisions of their Court of Appeals, requiring valuation on present value.

The present unanimity of all our self-styled utility reformers in presenting legislation and systems of account seeking to base rates upon original cost or prudent investment, leads one to the belief that they have convinced themselves, at least, that the Supreme Court of the United States will soon abandon its line of decision basing rates, as well as depreciation charges, upon the present fair value of the property used and useful in the public service. It is certain that they could have no such advance information from that august body, yet each and all seem in common accord on this subject, even down to the author of the Rayburn Bill. And unless upon a new presentation of the matter the Supreme Court reverses its long-sustained position, these systems are illegal and void, and will be productive of nothing but expense to the public and the utility.

But Are Estimates "Original Costs"?

There can be little question as to the right of the Commission to subdivide accounts, and it is probably within their right to require a subdivision of the property account which would show original cost if that can be obtained, since it is one of the elements to be considered in the determination of present value. It is not so clear that they have the right to require a company to subdivide the account by placing on its books *estimates* of original cost instead of facts. It is an absolute impossibility for any but the most recently organized companies to show original cost for the various classes of property. The fact that a company has had an uninterrupted course of operation for sixty to eighty years, the full period of its existence, lends no aid whatever, for early methods of bookkeeping provided no such data. It is, of course, true that in making retirements it becomes necessary to estimate original cost and it may be argued that if an estimate is a proper basis for making a credit to property account upon retirement of property, it is equally proper to make an estimate which is to be but a subdivision of an account, which in another subdivision will show the balance of the account and in the aggregate the correct total.

If the system of accounts contained nothing further than an order requiring this subdivision of the property account, little objection could be made to it from a legal standpoint. But it does not stop there. Notwithstanding there is no openly avowed intention of using original cost as a rate base, there is an express prohibition against accruing a depreciation charge against any portion of the cost of the property other than that represented by original cost. There is one exception. It permits what is termed "amortization" of that portion of cost which the company was authorized by the Commission to pay over original cost. Omitting, for the moment, this exception, which applies only in few instances, we find that the utility is limited in the collection of depreciation to a loss of value based on original cost to itself, if it were the constructing company, or original cost to the predecessor company which first installed the property in public service if purchased as a unit. This is plainly a violation of the constitutional right to earn the cost of operation, plus a reasonable return on present value. These accounts further provide that any depreciation accrued upon that part of cost in excess of original cost, as defined, must be charged to surplus account. The effect of this provision is further illustrated in the account which I wish next to discuss—the

Utility Fixed Capital Purchase Adjustment Account

This account is indeed a startling innovation in utility accounting and acts retroactively as well as prospectively to purchases of fixed capital constituting an

operating unit or system. In the event of the purchase of such an operating unit or system the utility is required to first enter in its depreciation reserve the depreciation reserve found on the books of the company purchased. It must then set up in Account 100, known as "Utility Fixed Capital in Service" account, the original cost either to the vendor or to the predecessor company from which it may have directly or indirectly purchased the property. The balance or difference between the cost of acquisition and the original cost, as defined, shall be charged or credited, as the case may be, to the new account, 103, known as "Utility Fixed Capital Purchase Adjustment." This, again, must be subdivided, but for the present it is best to keep within the principles involved and you should know:

First, that Account 103 is made a separate balance sheet account. There is no main account showing the entire amount of the investment in fixed capital. Instead there are four separate accounts, as follows: 100, Utility Fixed Capital in Service; 101, Utility Fixed Capital Under Construction; 102, Property Held for Future Utility Use, and 103, Utility Fixed Capital Purchase Adjustment. The very title of this purchase adjustment account is a misnomer and is indicative of the fact of a question or dispute. It conveys no intimation that it represents actual value to the company. Were it to be made a subdivision of the fixed capital account, it would be bad enough, but standing alone it can have no other effect than to mislead a stockholder or investor as to the amount of the investment in fixed capital.

Secondly, it assumes that the depreciation reserves set up by the predecessor company are in effect a return of capital paid by the consumer or the public, and something in which the public have a vested interest. To go back a moment to the theory of "aboriginal cost." It is necessarily predicated on the thought that property once dedicated to public service and remaining thereafter in public service is entitled to earn only on its cost at the time it was first dedicated. This theory is, of course, in direct violation of the decisions of the United States Supreme Court, holding that a utility is entitled to earn upon present fair value. But matters of settled judicial construction are given no recognition by the proponents of this system of accounts. Since the reasoning is that a utility is not entitled to earn on more than the first cost of the property, it follows that it cannot recover as a depreciation charge for the consumption of that property more than the proportionate loss of service value based on first cost. The purchase adjustment account, however, takes another step in advance and says that the public having once contributed to a predecessor utility a given amount for depreciation of this property, it operates as a return of capital to that extent and neither the utility, nor any subsequent purchaser, may earn on more than what is termed *"net* original cost," the difference between original cost, or "aboriginal cost," if you please, and the reserves which had at any previous time been set up against the property. In other words, property once devoted to utility service may pass from hand to hand but may never earn on more than its original cost, less the amount of any depreciation accrued on it at any time, by any company, and in any way, since its installation.

Fundamental Facts Overlooked

These theorists have overlooked several fundamental facts, even though, for the sake of argument, we assume that they are right in guessing that the Supreme Court is going to reverse its long line of decisions and fix original cost or prudent value as the rate base. They have overlooked the fact that depreciation reserves have been accrued in the past excessively as well as inadequately. They overlook the fact that these reserves have been accrued by appropriations from surplus, sometimes by profits thrown into the reserve, and by a variety of ways. They overlook the fact that these reserves have been accrued in the past upon cost to the accounting company and not an original cost, and you will not *now* be surprised to learn that when you have subdivided your fixed capital into various accounts, the present depreciation reserves are made to apply only against original cost. The public gets the advantage of the whole of the reserve, and it has credit for having paid the whole amount to the utility as a return of capital (original cost). When the balance of original cost is paid, there remains the unescapable conclusion that the property belongs to the public, or, what is equivalent, it must be operated without return. They also overlook the fact that since 1923 accruals have been wholly to a retirement reserve, without any intention of providing for what is now known as "Straight line depreciation." They overlook the further fact that the United States Supreme Court in the New Jersey case against the Bell Telephone Company decided that payment for the consumption of property (depreciation) was an operating charge and a part of the price paid for service, and that it belonged to the utility the same as its return.

The requirement that the depreciation reserve of the former owner be impounded and carried onto the books of the purchasing company is a direct appropriation of property if the reserve is excessive, for it takes it from the control of the owner and forbids any earning on the excess value. If the reserve be inadequate, it results in a misstatement of the property values, for the system of accounts, as you will find later, contemplates and provides that the depreciation reserve on the property shall be adjusted to reflect actual accrued depreciation, based on the straight line method. Taking in new properties with an inadequate reserve immediately throws the reserve out of line and violates uniformity.

It is apparent that the author has designed his work with a view to preventing abuses which have occurred in the past on the part of certain operators and during a period of rising commodity prices. While he has carefully guarded against the possibility of writing up the cost of property, he seems to have wholly forgotten that properties are bought for less than original cost, and that for the next decade purchases are apt to be on that basis.

A Hypothetical Case

Let us take, for instance, the purchase of a street railway company. Under this system of accounts, if a utility bought a street railway company for $1,000,000, the original cost of which was $10,000,000, and the earnings on which had never been sufficient to set up a depreciation reserve, it would require a credit or profit in the Purchase Adjustment Account of $9,000,000. The property would go on the books at original cost and would be entitled to an accrual for depreciation on that amount. The effect would be to put a tremendous red balance in the Purchase Adjustment Account, which is an asset account, and which would have the effect of neutralizing $9,000,000 of property value on the balance sheet and obliterating $9,000,000 of actual property values. The provision in the system of accounts would make this gain of $9,000,000 capital surplus, except as it would be carried as a credit to the Purchase Adjustment Account.

It seems that this incongruity may

have occurred to the author at some time or another, for he provided in an instruction in a different part of the accounts that no property should be entered on the books at an amount greater than cost to the accounting company except on order of the Commission, which brings to us this thought: The authority of the Commission is to establish a uniform set of accounts and by these provisions the Commission asserts its view of the necessity of subdividing the operating property accounts so as to show original cost. It then provides that the subdivision, or Account 100, shall contain:

First: Original cost when known;

Second: An estimate of original cost when not known;

Third: Not more than cost to an accounting company, unless the commission orders it;

Fourth: Present value when transferred from certain accounts;

Fifth: The actual original necessary and reasonable cost on property constructed;

Sixth: Original cost to a predecessor company when property is purchased as a unit;

Seventh: Cost to the accounting company, when the same amount of property may be purchased but not as a complete operating unit or system.

The Commission thus defeats its own purpose and under the guise of installing a uniform system of accounts whereby they would have the benefit, for purposes of comparison, of original cost, they decree that this account shall show and contain every variety of cost.

It is a plain contradiction of the defined purpose of the account, and it should be held illegal because not within the concept of uniformity.

The Perpetual Inventory

The system requires that within eighteen months from the effective date of the system the utilities shall complete a property record, better described as a perpetual inventory of all its property. It further provides that not later than six months from the effective date the company shall file with the Commission a verified statement showing for each subdivision of its fixed capital accounts a list of the types of property which are to be accounted for as units of property. These may or may not be the units determined for purposes of depreciation, but they are defined to mean those items which, when retired, will be accounted for by crediting the book cost to the fixed capital account. Elements of property are defined to mean the component parts or items of which units of property are composed. Elements would be replaced through maintenance, whereas units of property would, on retirement, be charged to the depreciation reserve. The completion of this type of property records for a large company is practically impossible within the time limit, and the expense is something tremendous. It was estimated by the metropolitan companies in New York that it would cost $7.35 per thousand of fixed capital and .39 per thousand of maintenance. For installation of the depreciation accounting the cost was estimated at $2.75 per thousand of fixed capital, and $1.09 for maintenance. For the entire state of New York it is estimated that the cost would exceed $21,000,000, and the cost of annual maintenance $3,000,000. Experience in some of our midwestern companies indicates a cost somewhat less than this, but the systems may be different. The New York utilities are urging that the cost is out of all proportion to the value of the accounts and that with rising expenses and falling income, it is wrong to burden either the public or the utilities with it at this time. As far as the New York Commission was concerned the plea fell on deaf ears.

The purpose of this inventory is to provide a method of arriving at a valuation quickly by the application of price trends, and it is not without its virtues. There is a distinct feeling upon the part of many operators that as a practical matter it cannot work out, but experimental work has been done for many years by certain of our companies, and opinion seems to be more or less divided as to its efficacy. The Wisconsin Commission has, for some time past, interested itself in the possibilities of such an inventory as an aid in rate-making, and has been cooperating with a local company in the development of a plan. It feels strongly that something of the kind must be worked out in order to avoid the long delays in inventory and appraisement to obtain present value, and we think beyond question that this provision will be adopted in that state.

Straight Line Depreciation

The system of accounts provides not only for the accrual of straight line depreciation in the future, but contains a retroactive provision requiring each company to begin at once an analysis of its fixed capital accounts, and its depreciation and amortization reserve applicable thereto, for the purpose of reporting to the Commission within eighteen months.

(1) The original cost of its fixed capital;

(2) The cost to the accounting company;

(3) The amount which should be in the depreciation and amortization reserves on the basis of original cost;

(4) The amount which should be in these reserves on the basis of cost to the accounting company.

Within six months the company is required to file a verified statement of its estimate of the average annual rate for depreciation for each class of property, and of the composite rate required for its fixed capital in the aggregate. This estimate must be based upon the estimated service values and service lives of the property, developed by a study of the company's history and experience and other available information. It must be computed on the group plan and the straight line method.

It should be remarked that in 1931 Wisconsin passed a statute providing for depreciation accounting. This statute has been construed by the Public Service Commission to provide for straight line depreciation, but a careful analysis would seem to indicate that it does not specifically provide for straight line depreciation as it is now known. It does provide for the periodical charge to operating expense of such amount as is determined necessary, and with the consent of the Commission it may be accounted for on a sinking fund basis. The statute further provides that no charge shall be made to the depreciation reserve for anything except losses on property actually retired from service. It does *not* provide that the money shall be retained in a fund.

Few of our states have a specific provision for depreciation accounting, and it is being urged on behalf of the utilities in New York that there is no warrant of law for a similar requirement for straight line depreciation as contained in these systems of account. Curiously enough, the Wisconsin statute in no place provides that depreciation shall be based upon anything other than cost to the accounting company, and one section would seem to preclude the theory that depreciation charges may be limited to original cost to a predecessor.

Impractical, But Bobs Up Again

The provision requiring the determination by the company of past accrued depreciation not provided for was in the new system of accounts when it was first proposed by the New York Commission. After many hearings on the matter, the provision was omitted as being intensely impractical, and it was eliminated. It has, however, bobbed up again in the proposed system for Wisconsin and will again have to be fought out.

It is apparent that no theory of straight line depreciation can be applied to past periods when maintenance and depreciation were handled in various and changings ways and when replacement accounting oftentimes injected substantial values into plants which under reserve accounting should be capitalized.

It is needless to say to you that depreciation does not accrue in a utility property by any fixed rule and that an accrual upon a straight line basis is purely an estimate which must be checked from year to year in order to determine its accuracy. It is intensely theoretical and its requirement is probably contrary to law and to sound business policy.

At least in respect to properties of long life, this method of accruing depreciation will greatly increase the cost of utility service to the consumer and will in effect, when consideration is given to the amount that may be earned upon the reserve, accrue within the estimated life of the property an amount sufficient to replace the property several times. It is apparent that the design of these radical regulators is to depreciate the rate base of the utilities by deducting from either original cost or present value the amount that should be in the reserves based on the straight line theory of depreciation. It has been estimated that the larger New York companies would be subjected to a deduction of 35 to 40 per cent of their value in this method. A finding that there was a large amount of accrued depreciation in a property, determined wholly on the age life theory, necessarily involves a find that the annual loss recoverable by charge to operating expense is correspondingly large. This will substantially increase the present charge to the consumer, but it is apparently the belief of these men that the depreciation of the rate base is of the greater importance. This can be readily understood in view of the present campaign for municipal ownership, and the intent is very evident. Knowing that the utilities are in a position where, due to competitive causes, great numbers of them cannot earn a fair return, regardless of rates, they are perfectly willing to permit them to accrue a larger amount as an annual charge, if it, in turn, would substantially reduce the rate base and leave the property where it could be condemned at a tremendously depreciated value.

Contributions for Extension and Donations in Aid of Construction

The system of accounts provides for segregation of "donations in aid of construction" and contains the further provision that "contributions for extensions" shall be transferred to the former account whenever the time shall have expired in which the contracting party can obtain a refund of any part of the original contract price. The theory of the author apparently is that any donation made to the utility, or any gain that the utility may make in the way of acquiring a guaranty for an extension, is something upon which it cannot earn. Contracts for extensions in new territory are no other or different than improvident additions to equipment. The reason for the requirement of a guaranty is because the extension will not pay a return. The utility in making it has no way of binding the public to pay a return on the property and must accept sole responsibility for its future operation. The theory of the author seems to be, however, that if and when the line finally pays, the public may elect to allow the company to accrue a depreciation charge to maintain the extension and thereupon the property belongs to the public to the extent that the utility may not earn on it. Without regard to those legal decisions holding that the company cannot earn on a straight donation in aid of construction, there seems to be no justification for a ruling that the public owns such profits as are made by a risk taken solely by the utility, for indeed the utility binds itself to furnish service continuously to the party contributing for the extension, and the public could refuse to allow an improvident extension to be included in the property of the utility upon which it had a right to a fair return.

Income Taxes

Notwithstanding the decision of the United States Supreme Court that income taxes are a charge to operating expense, the proposed system of accounts forbids their charge to operation and provides that they must be charged to net income.

Affiliated Companies of Affiliated Interests

The system of accounts carries a recitation of the Wisconsin statute defining affiliated companies or interests. In general, this includes every corporation or person owning or holding, directly or indirectly, 5 per cent or more of the voting stock of a utility, or in a chain of successive ownership of 5 per cent of such securities, and every person who is an officer or director of such utility or of any corporation in any chain of successive ownership. It further covers every corporation which has one or more officers, or one or more directors in common with the utility, and every corporation or person which the Commission may determine is actually exercising any substantial influence over the policies and actions of the utility. The system of accounts provides that every transaction with an affiliated company or interest must be first carried in a clearing account and from that charged to the appropriate accounts. Elaborate records shall be kept to show the reasons for the expenditures, data to show the cost to the affiliated company of each item, and the basis for the clearance from the account.

The character of these provisions is such that it is almost impossible for accounting officers to keep up to date a record of all who would be affiliated interests. For instance, it was found that the Y. M. C. A. was affiliated with one of the metropolitan utilities; several churches were affiliated; and, in one case, the Public Service Commission itself was affiliated. No attempt was made to limit the special record of transactions with all affiliated interests as defined by the statute, with one exception, which indicates the loose thinking used in both the New York and Wisconsin classifications. Each provides that no such person or corporation shall be considered as affiliated within the meaning of this definition if such person or corporation shall not have had transactions or dealings other than the holding of capital stock and the receipt of dividends thereon, during the two-year period next preceding. By virtue of this provision any affiliated interest is privileged to commit arson, robbery or theft once in two years without having its name inscribed in the affiliated clearing account. The system lends its aid to affiliated interests who are willing to take turn about in dealing or contracting with their company.

I have outlined the major innovations in this system and have omitted a myriad of minor ones. Costs of accounting have increased tremendously during the past few years and are now a very substantial factor in the cost of service. In the case of one large Wisconsin utility such costs have in late years increased over 500 per cent. The proposed system would increase them another 1000 per cent or more. It is but another sidelight on the growing cost of government. And as a device to aid in regulation, as it is described by the author, it will be an expensive child.

Personnel of E.E.I. Committees for 1935-1936

Appointments to membership on the technical committees of the Institute, for the administrative year 1935-1936, have been practically completed and acceptances had been received from nearly all appointees as this issue went to press.

Most of the committee chairmen plan to hold meetings of their committees during September or October. Committee members will be notified of the time and place of such meetings.

The appointments to committee membership are as follows:

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Canadian Convention

The 45th Annual Convention of the Canadian Electrical Association was held at St. Andrews, N. B., June 26-28 inclusive. An unusually successful meeting was held with an attendance of 225 delegates from all parts of the Dominion.

Among those delivering addresses, papers and reports to the Convention were: Messrs. H. I. Anscombe, Wills Maclachlan, E. J. Turley, Alexander Maxwell, W. C. Mainwaring, Prof. C. V. Christie, McNeely DuBose, J. F. Roberts, J. L. Clarke, H. B. Abbott-Smith, R. H. Mather, C. Gliddon, George Templeman, H. P. Sparkes, R. B. Baxter, R. F. Howard, Charles Taschereau, J. E. Lawson, R. A. Merritt, F. L. Foster, G. A. Lavoie and D. W. Koppes.

The retiring President, Mr. John Morse, General Superintendent of The Shawinigan Water & Power Company, delivered a notable address in which he sounded a note of very definite optimism for the future of the electrical utility industry in all parts of the Dominion. Mr. Morse stressed the importance of power companies everywhere making certain that the general public understood the problems, the policies and the achievements of the industry, and he urged upon all power executives the advisability of taking the public they serve into their complete confidence in order that misunderstandings regarding rates and other misconceptions about the electrical business would be cleared up for the present and prevented in the future.

Mr. Morse warned his hearers about the flood of power propaganda from Washington, much of which had spread into Canada. He cited such enterprises as the Tennessee Valley Authority and the Passamaquoddy Tidal Scheme as examples of non-self-liquidating projects, the real significance of which is difficult to secure from the propaganda which their zealous governmental advocates are so persistently broadcasting.

Officers elected for 1935-1936 were:

President—R. B. Baxter, Calgary Power Company, Limited, Montreal, Que.

Vice-Presidents—E. H. Adams, British Columbia Electric Railway Company, Limited, Vancouver, B. C.; R. H. Mather, The Shawinigan Water & Power Company, Montreal, Que.; M. C. Gilman, Winnipeg Electric Company, Winnipeg, Man.

Treasurer—J. B. McCabe, Montreal Light, Heat & Power Cons., Montreal, Que.

Secretary—B. C. Fairchild, Canadian Electrical Association, Montreal, Que.

—B. C. F.

McGraw Prize Paper

A Method of Locating Faults on Overhead Transmission Lines by Means of High Frequency

By J. E. Allen and G. J. Gross

MR. ALLEN

This paper, which won the First James H. McGraw Award for 1935, was written jointly by Messrs. Allen and Gross of the Pennsylvania Water and Power Company.

Mr. Allen's service in the company covers a period of 18 years. He graduated from Pennsylvania State College in 1916, B.S. in Electrical Engineering. Prior to entering the service of the Pennsylvania Water and Power Company he was employed by the Ridgway Dynamo & Engine Company, Ridgway, Penna., for one and a half years. He was a member of the Testing Department of his present company for five years when he was made Chief of Tests, which position he now holds. Mr. Allen has had charge of all tests and investigations of power house, substation and transmission line equipment (electrical, mechanical and hydraulic). Since the start of the Safe Harbor Water Power Corporation, he holds the same position with this company.

Mr. Gross's service with the company began in 1930 as a member of the Test Department. He is now Electrical Assistant to the Transmission Engineer and his work has dealt mainly with tests and investigations of high voltage transmission. Mr. Gross was employed by the Pennsylvania Power and Light Company of Hazleton, Penna., from 1927 to 1930 as Electrical Inspector, Construction Department, and Assistant to Superintendent of Transmission. He is a graduate of the Massachusetts Institute of Technology, 1926, B.S. and M.S. Degree in Electrical Engineering.

MR. GROSS

TRANSMISSION lines in the past have been subject to mechanical failures from many different causes, those of wet snow and sleet probably being the most common sources of trouble.

While the lines built in recent years are of superior design and construction, it cannot be said that they are entirely immune from mechanical failures. Locating failures resulting from wet snow and sleet by simple patroling frequently results in undesirable delays in effecting repairs and restoring service because roads are made impassable by snow drifts, telephone lines are interrupted at the same time the power line is down, and occasionally because of hindrance from darkness. In addition, great hardships are imposed upon patrolmen due to adverse weather conditions. One case has been known to require as long as 14 hours to locate the failure with the patrolmen stationed approximately 10 miles apart. Further separation of patrolmen would make delays still longer.

There has been a common need by power companies with extended overhead transmission systems for facilities whereby a break in a transmission line may be quickly located from the power house without resorting to the time consuming method of patroling the whole line to locate the failure. Such facilities would contribute in some measure toward meeting the increased standard of service now being required of high voltage transmission lines by reducing the time required for restoration of service to a minimum in the event of a mechanical failure.

The purpose of this paper is to describe a method employing high frequency for locating transmission line faults of a mechanical nature, which for all practical purposes fulfills the following requirements:

1—Less than one-half hour is required for the determination of the fault location on a three-phase line.

2—Determination of the fault location is not dependent upon the nature of the fault, i.e., open wire, short-circuit or ground.

3—No communication is needed with either the patrolmen or any other station (except in case it is necessary to sectionalize a line).

4—Apparatus can be operated and fault location determined with the regular station attendants.

5—The accuracy of the location in most cases is within 2%.

It is not within the scope of this paper to discuss and compare all the possible methods for locating faults on transmis-

sion lines. In general, any one of the particular methods used in the past is applicable to only certain types of faults, or is subject to other severe limitations, such as time required or necessity for communication. It is believed that the method herein described has wide application for fault location in the high voltage transmission line field.

Description of Method

If a source of continuously variable frequency is impressed upon one phase of a transmission line, as in Fig. 1 and the frequency varied, starting at zero and increasing slowly, it will be found that the current into the line as read on the ammeter behaves in a manner shown in Fig. 2 that is, when the frequency is increased to a certain value, the current suddenly builds up to a high value with a sharp peak and quickly decreases over a relatively small frequency change. As the frequency is increased a second sharp current peak or node is encountered and as a further frequency increase takes place, a third, fourth, fifth, etc., or indefinite number of nodes appear. It has been found that for a given length of line the differences in frequency between successive nodes *d* are equal and have a direct relationship to the length of the line. That is, if this frequency difference *d* for a 40 mile line is 2290 cycles, then the difference for an 80 mile line will be 1145 cycles, or for a 20 mile line the difference will be 4580 cycles. This relationship between distance and frequency difference between current nodes in brief constitutes the basic principle of the method described in further detail below.

The practical application of this phenomenon requires a continuously variable frequency oscillator, preferably of the beat-frequency type, and a graphic ammeter capable of responding to the complete range of oscillator frequency so that a graphic record with current as ordinate and frequency as abscissa can be drawn similar to Fig. 2. Contrary to usual practice where a graphic record is a function of time, the abscissa of the graphic record on the fault locator ammeter is a function of frequency, and accordingly the ammeter chart drum is mechanically coupled to the frequency control on the oscillator. Fig. 3 shows the above arrangement of apparatus. From the current graphs produced by varying the frequency, the difference in frequency between any two successive current nodes may be used

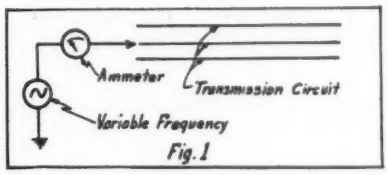


Fig. 1

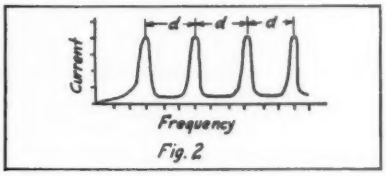


Fig. 2

Fig. 3

in the distance frequency relationship but in practice greater accuracy is secured by using the average difference for a large number of consecutive nodes. A clearer understanding of the practical application of the method may be gained from a description of the apparatus and the technique employed as given below.

Theory

The theory underlying the foregoing phenomenon involves the principle of reflection and phase shift which a current impulse undergoes when impressed on a transmission line having distributed capacitance and inductance. Such an impulse travels along the line at a velocity nearly equal to that of light and undergoes an attenuation in magnitude as well as a time lag or phase shift with respect to the sending end. As the impulse encounters an irregularity, such as the far end of the line or a short circuit, it is reflected with either like or opposite polarity depending upon the termination or condition of open circuit or short circuit, respectively. The reflected wave then travels back toward the sending end at the same velocity and with additional phase shift. This effect is equally true for a single current impulse or a continuous series of impulses such as an alternating current of a given frequency. If such an alternating current is impressed on a transmission line conductor as in Fig 1, and if one cycle undergoes a total phase shift going out and returning of 360°, it will be in phase with the next successive outgoing cycle, reinforcing it and producing a condition of minimum impedance or maximum current into the line. If now the frequency is increased a sufficient amount, the reflected cycle will arrive back at the sending end in phase with the second successive cycle, again reinforcing it and resulting in maximum current into the line. A further increase in frequency will result in a repetition of the above phenomena thus producing a large number of recurring conditions of minimum impedance which repeat at the same frequency difference. When the frequency is slowly varied through one of these conditions of minimum impedance so that the change of current can be observed, the effect is to produce a so-called "current node." The formula expressing the above relationship is as follows:

$$L = \frac{V}{2(f_2 - f_1)}$$

where

L = Distance in miles to the fault.

$(f_2 - f_1)$ = Average difference in frequency between successive current nodes expressed in cycles per second. This difference is referred to as *d*.

V = Velocity of propagation in miles per second. This velocity is nearly equal to that of light but has to be measured for each circuit to secure the maximum accuracy.

Use of the term "resonance," in referring to current nodes, has been purposely avoided as it is preferred to associate resonance with circuits of lumped inductance and capacitance. The term "current node" is believed to be more descriptive of the phenomenon.*

Current Node Characteristics

One of the outstanding characteristics in the behavior of the current nodes is the fact that the difference *d* between consecutive nodes is the same regard-

* The phenomenon of recurring current nodes was encountered on our 70 kv circuits experimentally when investigating the possibilities of utilizing high frequency as a means of locating faults. After the principles were established experimentally, reference was found in technical literature to a method in use by the associated Bell Telephone Companies for locating faults on communication circuits, similar in theory to that described above but differing considerably in practice. The telephone companies plot values of impedance obtained by direct bridge measurement and thereby secure recurring impedance curves from which the frequency difference existing between maximum impedance peaks is obtained and used in determining fault location. In contrast to this practice, the method described in this paper, whereby minimum impedance as indicated by current nodes are graphically recorded, offers substantial advantages in time saving and technique. See A.I.E.E. Trans. Vol. 43, pp. 1331, 1924.

less of the nature of the line fault, that is, open, ground, or short circuit and for this reason the nature of the fault need not be known. Thus far reference has been made only to the application of the oscillator frequency between a phase and ground, but it has been found that the behavior of the nodes is identical in respect to the difference *d* between consecutive nodes when the frequency is applied between phases without any ground at the oscillator. However, there is a relationship between the frequency at which the first node appears and the difference *d* between the consecutive nodes depending upon the nature of the fault, and whether or not the frequency is applied between phases or to ground. For instance, when the frequency is applied between a conductor and ground the first node will appear at an absolute frequency equal to the difference *d* between consecutive nodes in case the conductor is grounded at the fault, but if the conductor is open at the fault, the first node appears at an absolute frequency of ½*d*. It is of some value to know the above relationship in case fault diagnosis is desired and the various conditions are accordingly given in Fig. 4.

A study of the various combinations

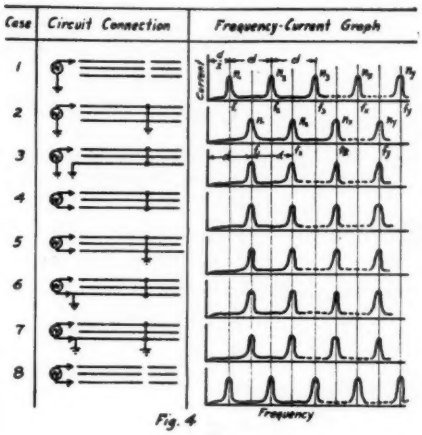


Fig. 4.

shows that for a given length of line the difference *d* between successive current nodes is always the same regardless of how the frequency is applied or the nature of the fault. However, exact fault diagnosis is not possible in all cases and in general need not be attempted except as a matter of interest. In order to minimize the time required for fault location a routine has been established utilizing the relationship shown in Fig. 4, whereby only three graphic records requiring three minutes each are needed to permit a location to be determined.

Oscillator Frequency Range

The oscillator frequency limits are set by several conditions. In order to secure the current node appearing at the lowest frequency, the minimum oscillator frequency should be less than $V \div 4\,L$, where L is the length in miles of the circuit to be tested. This means that the longer the circuit, the lower the frequency required to secure the first node.

The maximum frequency should be greater than $V \div L$, where L is the minimum length of the circuit within which no fault location determinations are desired. From the above relationship it is seen that the shorter the distance to the fault the higher the frequency required to produce recurring nodes. As a result, there must be a compromise between the minimum distance within which fault location is desired and the maximum frequency needed on account of the practical limitations in oscillator and amplifier design. As an example, assuming an available oscillator range of 0 to 100,000 cycles, and based on the requirement that at least two current nodes are needed, and that the second node should occur at somewhat less than 100,000 cycles, or say 96,000 cycles to show the peak of that node, then the minimum distance

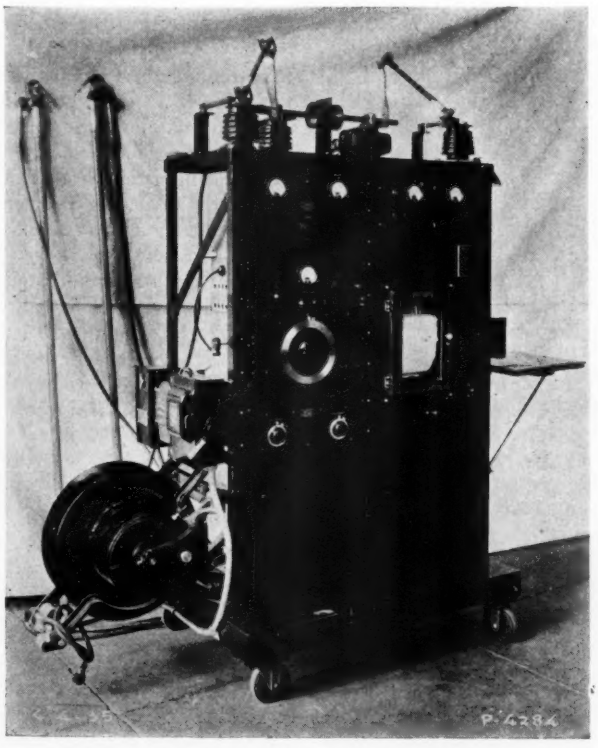


Fig. 5-a—Front View of Test Equipment

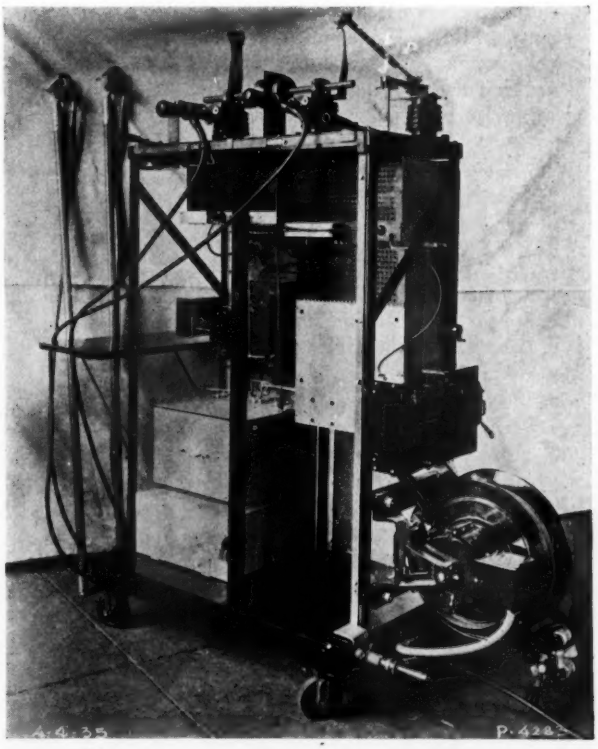


Fig. 5-b—Rear View of Test Equipment

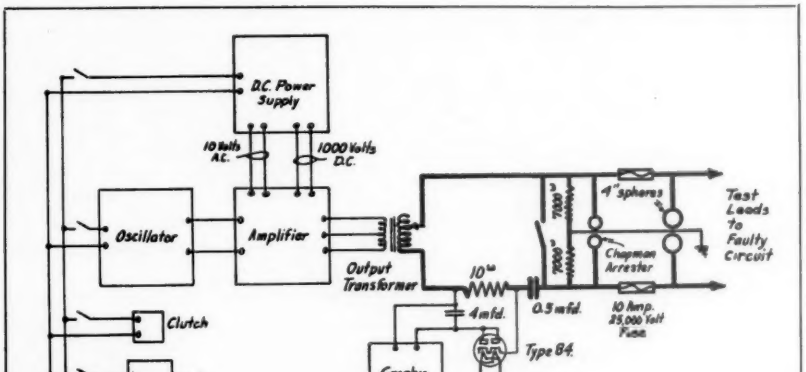


Fig. 6

to a fault involving a ground will be V ÷2 (96,000 — 48,000) = 1.9 miles approximately. Similarly for a fault involving an open conductor, the minimum length of line which can be tested will be V ÷ 2 (96,000 — 32,000) = 1.4 miles approximately.

Description of Permanent Test Equipment

The fault locating apparatus consists essentially of a panel mounted beat-frequency oscillator, amplifier and associated power supply (all three units designed and built by the General Radio Company to meet our requirements), a panel mounted graphic milli-ammeter, rectifier, output transformer, protective apparatus and connected cables. This equipment is mounted on a portable truck approximately 2 ft., 6 in. wide, 6 ft. long, 6 ft., 9 in. high, weighs approximately 1000 lb. complete and is intended for use on twelve 70 kv circuits that radiate from the Holtwood Power House. See Fig 5.

A—*Oscillator*—The oscillator operates upon the beat frequency principle and provides a continuously variable source of frequency from 100 to 100,000 cycles per second, obtained from the difference between a fixed oscillator of 500 kilocycles and one variable between 500 and 600 kilocycles. The output of this oscillator is of good wave shape, the voltage is practically constant over the frequency range and it is capable of delivering approximately four watts from the two 2-A-3 push-pull output tubes. The power supply for the unit is obtained from the 110 volt, 60 cycle supply and is self contained in the oscillator.

The main frequency dial which is 8 inches in diameter has nearly a linear characteristic for angular rotation versus frequency increment, and its calibrated portion covering 270 degrees is marked at every half kilocycle permitting it to be read within 100 cycles over its entire range. A mark upon the dial at 100 cycles permits a frequency check to be made by comparison with a tuned reed, adjustment being made with a vernier condenser on the fixed oscillator. Output voltage is adjustable, and is indicated upon a panel voltmeter.

B—*Amplifier*—The amplifier unit contains two 50 watt tubes similar to Type 203-A connected in push-pull. A continuously variable grid bias voltage is obtained from a self contained rectifier unit using a Type 80 tube and obtaining power from the 110 volt 60 cycle supply, thus permitting operation either as a Class A or Class B amplifier.

C—*Amplifier Power Supply*—The power supply unit operated from the 110 volt, 60 cycle line serves the dual purpose of supplying 10 volts a-c for the filament as well as 1000 volts d-c for the plates of the 203-A amplifiers. Two Type 866 tubes are employed as rectifiers. The d-c voltage output is continuously variable from zero to full rated value. A time delay switch provides the necessary time interval between the heating of filaments and application of a-c voltage to the 866 rectifiers. A panel mounted voltmeter and milliammeter indicate d-c power output.

D—*Graphic Ammeter and Rectifier*—The ammeter that records change in current to a faulty circuit under test is an Esterline Angus Type AW direct current graphic milliammeter with suitable rectifier that will give response throughout the frequency range up to 100 kilocycles. See Fig. 6. In the output circuit is inserted a 10 ohm shunt wound with nichrome wire upon a thin transite strip to reduce inductance. Voltage drop from this shunt is fed to the graphic milliammeter with its associated rectifier. The latter is a Type 84 tube, with both anodes tied together to make it a half wave rectifier. A decided advantage of the 84 tube, seldom found on other types of heater tubes, is the high insulation within the tube between cathode and heater, permitting the application up to 350 a-c volts between them. This, combined with the high insulation and low capacitance provided between the rectifier heater transformer secondary winding and core secured by special transformer design, reduces the leakage and stray capacitance currents to ground to a minimum. The graphic instrument itself is of a standard 0-5 milli-ampere flush mounted switchboard type, has a d-c resistance of 550 ohms, is magnetically damped, and draws an ink record on a roll chart six inches wide. Instrument deflection is improved by a shunt four microfarad capacitor. To draw current ordinate lines at the limit frequencies of 100 and 1 kilocycles denoting the beginning and end of a test record, a short circuiting switch across the output leads permits building up of output current to full scale value by manipulation of oscillator voltage control. The milliammeter and associated rectifier provide a linear relation between meter scale deflection and a-c voltage drop across the 10 ohm shunt. Full scale deflection is equivalent to .4 ampere through the 10 ohm shunt. Inasmuch as amplitude of the ordinate of recorded current has no significance, and abscissa of frequency is translated from a scale, blank chart rolls are used.

E—*Output Transformer*—Transfer of energy from the amplifier to a circuit under test is made through a special design of push-pull output transformer. See Fig. 6. The turn ratio was established by matching amplifier plate impedance to the impedance of a faulty circuit (at minimum impedance), the latter impedance having been determined by experimental test. The two plate circuit coils are of 300 turns each

and wound in honey comb fashion to minimize distributed capacitance. The output coil is also honey comb wound and has taps at 30, 40, 50, 60 and 70 turns. The transformer core is of a shell type and is built up of annealed silicon steel laminations .003 inch thick.

F — *Protective Equipment — Direct Contact*—To protect operating personnel from hazard and the apparatus from damage due to accidental contact with other power transmission lines, certain safety features have been included. The frame of the fault locator truck is grounded through a cable having tapered plug terminals that can be inserted in the nearest jack of the station grounding system. The first protection consists of four inch spheres set at ⅛ inch gap on each output terminal to ground. See Fig. 6. Next in order, looking into the fault locating equipment, is a 10 ampere, 25,000 volt, S & C fuse. This is followed by a carbon block Chapman arrester having 0.025 inch gaps between line and ground. As a further protection to station wiring, a vacuum gap protector tube is connected to the 110 volt, 60 cycle supply line.

G—*Protective Equipment—Induced Voltage*—On account of the fact that voltages as high as 500 volts induced from a parallel circuit may be encountered on a circuit under test, the following measures were employed to minimize its effeet on the test results. A 7000 ohm graphite rod resistor on each lead helps to drain the voltage to ground. In addition a 1000 volt ½ M.F. blocking condenser placed in series with one of the output terminals serves as a high impedance to the 25 or 60 cycle induced voltage and prevents saturation in the output transformer and feed back to the amplifier plates. By using sufficient amplifier power output the effect of the induced voltage is negligible, and as a result tests may be made under circuit conditions when other test methods would be entirely useless.

H—*Connecting Cables*—Power feed to the portable truck is effected through a flexible cord wound on a spring-reroll type of cable reel. The cable is long enough to permit connection to any of the existing convenience receptacles. A ground cable has already been mentioned. Cables from the truck output terminals are attached to sectional hot-line wood sticks so that testing leads can be connected to any transmission line terminal or auxiliary bus without hazard to the operator.

I—*Chart Drive Motor*—The record desired from the graphic ammeter is one showing frequency as abscissa and current as ordinate, and hence the drum of the graphic is coupled mechanically to the oscillator condenser so that chart movement is a function of frequency. The coupling is so arranged that 18 inches of chart are produced with a full frequency range of 1 to 100 kilocycles which results from a 270° rotation of the oscillator dial.

To drive the graphic record, a 110 volt, 60 cycle continuously running motor is used. Coupling of motor to graphic instrument drum and connected oscillator is effected by meshing gears, either manually or by energizing a 110 volt solenoid. Motor speed and gearing are so arranged as to produce the 18 inch record in three minutes.

J—*Power Supply*—The fault locating equipment is operated entirely from a 110 volt, 60 cycle a-c source. No separate source of direct current or local batteries is required. The power consumption, when testing a faulty circuit, of oscillator, power supply, amplifier, motor, clutch, pilot lamps and graphic ammeter rectifier, is approximately 450 watts.

Operation of Equipment

When the equipment is needed for fault location it is moved to the circuit under test. The power supply cord is plugged into the nearest receptacle and the oscillator, amplifier, power supply and rectifier units are energized from 110 volts by the switches provided on the panels. In the meantime, the test leads are applied to the individual phases in accordance with certain routine procedure outlined in further detail below. The graphic meter pen is inked, the motor for driving the chart is energized and the oscillator dial set at 100,000 cycles by driving the chart forward with the motor drive so as to avoid backlash. At this frequency the pen is made to deflect full scale so as to provide a zero or reference in scaling off frequency when the chart is removed. When the circuit is in readiness for test the plate voltage and grid bias of the amplifier are adjusted and the voltage control of the oscillator set at about ½ scale. The chart is then started with the motor clutch, and the amplitude of the current nodes watched as they appear so as to re-adjust the oscillator voltage control if necessary. At the end of three minutes when the oscillator has decreased to 1 kilocycle, the chart is stopped and the oscillator set back to 100 kilocycles in readiness to test the next phase in accordance with the established routine. The operation of the equipment is thus seen to be fairly simple and well within the capabilities of the usual station attendants.

Technique and Routine Procedure in Locating Faults on a Three Phase Line

The faulty circuit is turned over for test with the far end preferably ungrounded, although if it is grounded it will not be a serious detriment. One lead of the test equipment so designated is connected to one of the three line phases and the other two line phases are grounded. The other lead of the test equipment is connected to ground so that the high frequency is applied between conductor and ground. A graphic record is then secured, after which the other two phases are tested in succession in like manner.

The three charts thus secured are immediately detached from the meter and with a rule having a frequency scale corresponding to the dial calibration of the oscillator, the frequency of the first and last well defined current node is read from the scale and the total difference obtained by subtraction. This difference is then divided by the number of "valleys" between the two current nodes chosen and an average difference d is thus obtained. This value may then be substituted in the formula $L = \frac{V}{2d}$ and the distance L thus obtained represents the number of miles to the fault. This latter calculation, however, is avoided by the use of a tabulation giving for each tower number on the line average frequency difference d corresponding to the distance L and for the value of V experimentally determined for the particular line. A sample of such a tabulation now in use is given below.

Average Frequency d in Cycles	Distance to Fault, L in Miles	Corresponding Tower Number
9175	9.97	100
9105	10.05	101
9020	10.14	102
8935	10.24	103
8830	10.36	104

Each of the three charts is analyzed in the above manner, after which the location designated by tower number is transmitted to the repair crews. Experience has shown that the three above charts may be secured, analyzed, and the fault reported in less than ½ hour.

However, immediately after the above procedure, three additional records are taken with the test leads connected be-

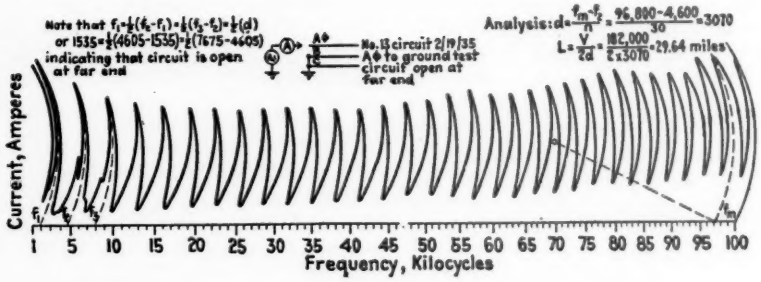


Fig. 7

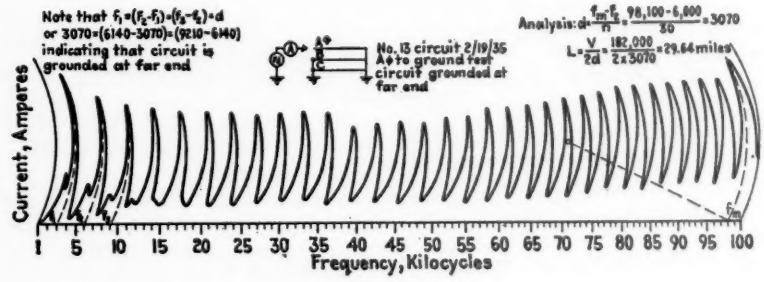


Fig. 8

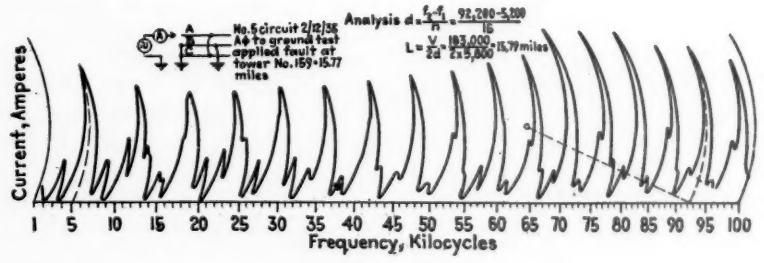


Fig. 9

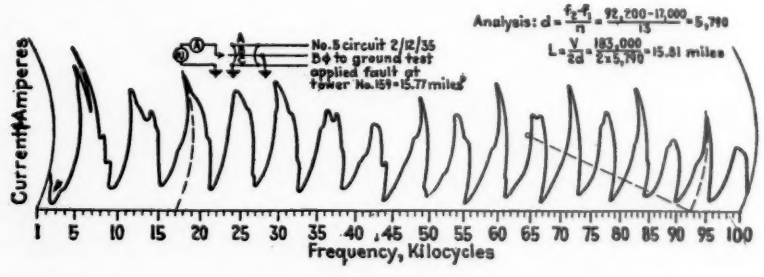


Fig. 10

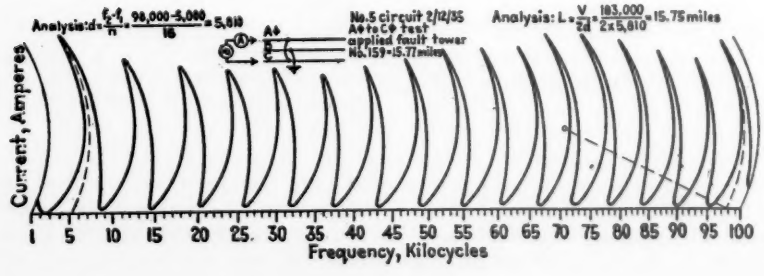


Fig. 11

tween phases, leaving the third phase ungrounded. These records, depending upon the nature of the fault, serve as a possible check on the location obtained from the first three records.

It is necessary to analyze each of the first three charts on account of the possibility of each phase having a fault at a different location. The above routine has been established as a result of a great many tests with artificially applied faults. It has been found that this procedure prevents taking an unnecessary number of charts and thereby wasting time which is so important when repair crews are waiting in readiness to proceed to the fault location. Experiments have shown, for example, that a between-phase fault without ground may be located in the first three tests by grounding the two idle phases at the testing end. Otherwise, as many as six records might have to be secured before obtaining one suitable for analysis. The reason for this is because the records secured by the phase to ground connection without the other two phases being grounded would result in distorted or irregular curves incapable of analysis due to the effect of the multiple conductors connected to the phase under test.

The above routine may then be summarized as follows:

1—The faulty circuit is turned over for test with the far end preferably ungrounded.

2—Three records are secured with the oscillator connected between one phase and ground with the other two phases grounded.

3—The three records are analyzed and the fault location reported to the repair crew.

4—Three additional records are secured with the oscillator connected between phases with the third phase ungrounded as possible confirmation of the location obtained from the first three records.

Results Obtained From Artificially Applied Faults

The following graphic records of current versus frequency obtained from the permanent equipment at Holtwood described above are submitted as typical examples of results secured with the method:

1—Fig. 7 shows the current node-frequency characteristic of one phase of a 29.7 mile line from Holtwood to Coatesville, Pa., with the far end open.

2—Fig. 8 shows the same phase with the far end grounded. These two charts illustrate the difference noted above, between a grounded and an ungrounded conductor.

3—Fig. 9 and Fig. 10 show current node-frequency characteristics secured from a fault 15.77 miles from Holtwood on a 40 mile line to Baltimore. The fault, artificially applied, consisted of a between wire short on A and

C phases (without a ground) and a ground on B phase at the same tower. These records were obtained under the procedure outlined above for securing the first three records (phase to ground). Only two records are given because two of them taken from A and C phases to ground are duplicates.

4—Fig. 11 shows one of the records secured from A and C phases with the same fault under the procedure outlined above for securing the last three records (phase to phase). Records secured of A-B and B-C phases are duplicates, but were not usable on account of the distortion and irregularity of the current nodes. This chart confirmed the location given in Fig. 9 and Fig. 10.

Discussion of Results

Some judgment must be exercised in the analysis of the charts on account of the distortion sometimes present in the current nodes. However, distortion of individual peaks must not be confused with charts showing a lack of regular repetition. The latter may be frequently encountered, in which case they are to be discarded. Errors in analysis due to distortion arise because of the uncertainty in defining the exact peak, but such errors are usually reduced to a negligible value by using the average secured from the large number of nodes generally available. Experiments with a large number of applied faults have failed to disclose a case in which distortion of current nodes was so serious that the chart could not be used with full confidence. In general as many of the nodes as possible should be used in determining an average difference d because some variation in the difference of frequency between successive nodes has been found to exist. It will be noted that the foregoing charts provide examples in which distortion is present. One means of minimizing this background of interference would be to provide a square law characteristic in the rectifier for the graphic milliammeter instead of the linear characteristic now in use and thereby produce a suppressing effect on the interference and at the same time tend to exaggerate the fundamental nodes desired. No effort has been made to analyze the phenomenon of distortion as it is beyond the scope of this paper, and for practical purposes it can be ignored.

Determination of Propagation Constant V

The propagation constant V was determined by securing the current node-frequency characteristics of a circuit of known length. The values obtained were found to vary between 181,000 and 183,000 miles per second. Instead of using the first and last current node in this determination, increased accuracy was secured by plotting the frequency of each individual node against the accumulated number of nodes. The slope of the straight line common to the points minimized the variation in differences between nodes and was accordingly used as a more accurate means of determining V.

Limitations

The apparatus installed at Holtwood has the following limitations:

1—When the fault is very close to the station two nodes may not appear on the record which means that the fault is within a certain known distance from the station. For the oscillator frequency used at Holtwood this distance would not exceed 1.9 miles.

2—Theoretically, if a circuit is terminated in an impedance equal to its surge impedance, the current impulses will be absorbed and there will be no reflection and no change of circuit impedance with a change in frequency. Such a condition may by chance result on a circuit without overhead ground wire where the conductor falls on a tower having a footing resistance equal to the surge impedance. No tests have been made to show the effect of termination impedance. It is believed, however, that a case such as the above would be a remote possibility.

3—On a circuit having taps or branches confusing graphs may result from reflections from the tap terminations. It may be necessary in such instances to sectionalize the circuit before testing for fault location.

4—If there is a double fault on the same conductor, only the one nearest the testing end can be located.

Conclusions

The ability of the test method and routine herein described to locate transmission line faults has been demonstrated by actual field trials on the 70 kv, 40 mile Holtwood-Baltimore lines in which the nature and location of the faults were unknown to the testing personnel. The faults were of a nature designed to simulate, as far as possible, probable mechanical failures resulting from wet snow and sleet, and included such conditions as a broken conductor lying on the earth clear of the tower, a broken conductor touching the tower, a broken conductor in contact with another phase, a broken conductor clear of both tower and ground, and two conductors in contact without a ground. These conditions were combined into four different tests, one of which had faults at two locations along the line on different conductors. Each of the other three tests had faults at three different locations and involved more than one conductor on the same tower. The locations varied between 7.5 and 38 miles from the station.

Each one of the faults was successfully located within an accuracy of 2 per cent and in less than ½ hour. The apparatus in use at the time consisted of experimental home-made equipment with an oscillator frequency range from 0 to 60,000 cycles, and the charts were drawn manually by following an indicating ammeter. Since then, however, manufactured equipment, as described above, has been installed permanently at Holtwood, and it is believed that the improved frequency stability and higher frequency range will permit fault location to be made with an accuracy much better than 2 per cent.

It is felt that the method and facilities for locating line faults described in this paper will contribute toward improved service from transmission lines for those companies which now are confronted with delays in restoration of service resulting from ordinary methods of patrolling lines to locate a mechanical failure.

It is believed that the method is also applicable to underground cables, although further experiment and development are required.

Power Sales Items

(See also page 335)

INDUSTRIAL CUSTOMERS

"Service to Industrial Customers," by W. E. Mitchell, Vice President & General Manager, Georgia Power Company. Electrical World, June 8, 1935, p. 67. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

No class of power consumers is in a better position to demand high quality electric service than the large industrial power customers. Mr. Mitchell relates the results of an intensive study of the causes of industrial customers' complaints and the method of solving the problems.

IRRIGATION

"Electricity for Irrigation Purposes." Electrical Production, June, 1935, p. 13. Electrical League of Cleveland, Inc., Builders Exchange Building, Cleveland, Ohio, Publishers.

Advantages and applications of electric water pumps in simplifying irrigation problems.

POWER COSTS

"Watch Maximum Demand to Cut Power Costs," by John M. Acheson. Power, May, 1935, p. 244. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

Power engineers will be interested in this article because it points out ways of limiting maximum demands, etc., thereby saving the purchaser of power money on his demand charge. The limiting of maximum demand is of interest to nearly every purchaser of power, and this article is written for the plant operator.

Byllesby Prize Paper

The Challenge to the Electrical Utility Accountant of Today

By R. E. Kerns

ACCOUNTANCY in every field of business has, today, reached a position of prominence and importance never before held by any other branch or department of industry. The past few years of depressed business conditions have served to accentuate its value and necessity. Management in every surviving enterprise has relied upon the accountant for the data and statistics from which it has largely molded its course and program against ruin and disaster.

Such an epochal ascent has been a result of neither chance nor fortune. Like an honest workman who has attained a position of responsibility through hard work and application of study, accountancy need fear no impending downfall during our present economic structure.

In the field of electric light and power, this established and enviable position of accountancy has proved no exception, although the layman might have thought that so technical an industry would have eclipsed accountancy with science. On the contrary, the profession of accountancy has not only been the bolstering element in the electric light and power industry since 1929, but it is now being relied upon as the Moses of the twentieth century to lead the industry out of the maze of uncertainty and siege in which it has found itself enmeshed.

Today, we find a situation, industrially and politically speaking, which has no parallel in the history of our nation. Not only is the duration of depression unequalled, but the attending circumstances are the most acute and annoying with which business in general, and the power industry in particular, has ever had to cope. The Federal Government seems intent upon grasping from our hands a service to mankind developed from a small beginning to luxurious fruition by honest, capable and far-sighted men—men of courage and brilliancy in every field of the industry, who have produced for the peoples of our nation a comfort in home and industry never imagined half a century ago.

MR. KERNS

Mr. Kerns' paper won the H. M. Byllesby First Prize for 1935

Mr. Kerns was born in Lincoln, Neb. He received his grammar school education in St. Louis and high school education in Muskogee, Okla., later attending college at St. Stephens, which is now a part of Columbia University. In addition to this training, he has been a member of several educational program classes of the Oklahoma Gas & Electric Company, particularly in Commercial Law and Economics of Public Utilities. Mr. Kerns joined the Oklahoma Gas & Electric Company at Muskogee, Okla., in August, 1926. Since that time he has worked in a number of different positions in the Accounting and Auditing departments. At the present time he occupies the position of General Bookkeeper for the Eastern Division.

Insofar as possible, the motives and politics of the situation will be excluded from this discussion. It is, nevertheless, of paramount importance to consider the trend of business and, to some degree, the political aspect in order to impress upon the accountant his challenge and privilege.

Perhaps the greatest governmental activity which has for its purpose the stifling of private power companies is the Tennessee Valley Authority project; and secondary to that alone is the municipal agitation which springs up almost overnight in cities and towns throughout the nation, and which is openly aided and abetted by Washington. Of the TVA, let it be said that its original purpose has been supplanted, or that it was originally veiled, purposely. The TVA was launched to serve as a "yardstick" to be used in whipping into line "the exorbitant rates of extortionate power companies." After the November elections of 1934, the President announced that he was well satisfied with the results of the TVA to date and that it was his intention to extend the program in the near future to cover every State in the Union.

Only one inference may be drawn from this statement—the intention of the Federal Government to take over the generation and distribution of electric current throughout the nation. The problem of successfully defeating this purpose, therefore, rests with every electrical utility in the United States.

With present conditions and the political and industrial trend in mind, the problem confronting our industry may be resolved into the following statement: For reasons largely political, the federal and the municipal governments are making a concerted effort to eventually place in political control a highly technical industry which has been fostered and carefully developed by private interests at a phenomenally rapid rate and at a constantly lowered cost.

Aside from the justice of the case (which has thus far been largely disregarded by political bodies) the only question which may be asked derogatory to such a procedure is this: "Can the political bodies continue to supply as adequate and satisfactory a service to the nation, and expand its use and the territory served, hereafter, at as low or at a lower cost than prevalent costs, *and at the same time* protect the taxpayer against the losses which may (and

are bound to) accrue from such a change of managership?"

The answer is positively and irrevocably, "No!" *But, who is to prove the answer?—and how?* We may point to other unsuccessful governmental ventures. This has been done with only a modicum of success. What the layman wants to know is, "why not," in this *particular industry*. He has been educated in the propaganda that the light and power industry is "different," that it lends itself naturally to political management. It is this fallacy that must be exploded *by the facts in the particular case* and the privilege and duty of clarification devolve, unquestionably, on the accountant. An onerous task—yes! But a privilege to himself and his company for existence, itself, and a duty to the customer and taxpayer in the economic sense which he, alone, is equipped to perform.

In the broad sense, the duty of the accountant is the accounting for and the supervision of the receipt and disbursement of all funds. Heretofore, his specific duties under this blanket responsibility were to improve procedures, to simplify systems, to propose economies of operation and construction, to explain differences in cost of service in different localities and to design rate structures to benefit that class of customer which, through economy of operation and increase in use of service, had proved deserving of such consideration. These duties he retains, but they must be used in conjunction with this new and important duty—*the uniform assembling of the facts under a national, standard system of accounting to be used in every attempt at political seizure; and their presentation in such a manner that the "Man in the Street" can easily see that the change will eventually be more expensive to him,* regardless of whether the service he received would be as satisfactory as at present and disregarding the justice of the case. We must realize that, today, the cost element has pushed justice and foresight into oblivion.

With this twofold challenge to the accountant in mind, the remainder of our discussion shall be divided into two major portions: The Standardization of Major Accounting Records and Standard Method of Presentation of Essential Facts to the Public.

Standardization of Major Accounting Records

Every electric utility in the nation has found that by the use of standard accounting procedure in the various members of its group, a more comprehensive and valuable picture of operations and net worth can be obtained. Today, with every major company facing the same serious problem, it would seem that uniform procedure in certain phases of accounting might be not only advantageous but necessary. Such accounting uniformity would produce one of two possible results: First, it would influence the federal utilities to make their records conform to the proposed national standards of the private utilities, thereby providing a fair comparison of efficiency between the two; or, secondly, it would, at least, provide a common basis of accounting for every electrical utility of the nation for the purpose of comparison with a governmental statement *adjusted to this common procedure.* Such a common fund of information would prove invaluable.

A detailed discussion of each record recommended for standardization would be obviously impossible in one paper. Its final preparation will necessitate intensive study and consideration by a forum of accountants from the various companies of the nation. Therefore, a more or less detailed summary of only one record—Fixed Capital Account—and a brief recommendation, only, for the Balance Sheet and Earnings and Expense Statement shall be here included.

Fixed Capital Accounting Procedure

The method of compiling capital additions and the retirements of property is at best a rather involved procedure, but likewise a very important one. Simplicity, insofar as it will not detract from the value or use of this record, should be utmost in the minds of those who shall design a standard method for its compilation.

The multiplicity of Capital Accounting procedure nearly equals the number of the major utilities, themselves. It is, therefore, with the idea of *uniformity* and *simplicity* in mind that the following Fixed Capital Accounting system is suggested as a possible standard for all electrical utilities.

The three steps of maintaining records of this nature may be considered as follows: First, the securing of authority for an expenditure on a new project through the medium of the installation estimate. Secondly, the accumulation of expenses authorized by the estimate. Thirdly, the retirement from the records of each portion of property removed or abandoned. In maintaining such records, in most cases, the requirements of three groups must be held utmost—the utility company and the regulatory body, as well as the customer of the utility. Bearing in mind these three requirements of Fixed Capital records and considering each group concerned with it, let us consider the following procedure as a more simple method of compiling such information without sacrificing any accuracy or real value of the results.

Simplified Fixed Capital Accounting Procedure

When an addition or improvement becomes necessary, an estimate of the project is prepared showing the material, labor and any other expenses necessary to do the work. If a removal of property is to be made, a removal estimate is prepared, showing the date and project number on which the original installation was made, the original cost of the property to be retired, the probable value of salvage to be removed and an estimate of the expense necessary to remove it. When such estimates have been approved they become authority to proceed with the work, withdraw the necessary material from stores and make the necessary charges of labor and transportation to the number assigned to the estimate. Orders for material are written and approved by the superintendent or his assistant. Labor and transportation are reported daily and posted to summary sheets, the totals of which are balanced with the payroll at the end of each month. Credits for salvage removed are likewise written up in the superintendent's office before salvage is placed in the storeroom. Such credits are prepared for all items removed, whether of value or not. Labor and transportation expense incurred in removing this salvage material is reported in the same manner as in the case of new construction.

At the end of each month the material, labor and transportation tickets are assembled. These various expenditures are compared with the approved estimate, and having been verified as to content and distribution, are posted to the job order recapitulation sheet (See Form A), showing material, labor and transportation separately on lines 1, 2 and 4, under the column bearing the appropriate account number. After liability insurance has been computed on each labor item and inserted on line 3, a total of these expenses, material, labor, insurance and transportation, may be determined on line 6. The salvage value of material removed is inserted in the

FORM-A.

NAME OF JOB — I. D. No. — MONTH — YEAR

Project No.	Engineering No.	Construction No.	Construction Job No.	Equipment No.	Equipment Job No.	Location	Budget Appropriation No.	Budget Item

Construction Totals	Items	Retirements, Scrap and Salvage
	1 Material	
	2 Labor	
	3 Insurance	
	4 Transp.	
	5	
	6 Total Undist.	
	7 Engineering, Accounting, Interest, Superintendence %	
	8 Gross Construction Total	
	9 Construction Price	
	10 Expenditures Prior to Date	
	11 Gross Construction to Date	
	12 Removed Property	
	13 Construction Salvage	
	14 Construction Price	
	15 Salvage Salvage	
	16 To Date Net	
	17 Appropriation Total Net	
	18 Estimate	

UNDISTRIBUTED CHARGES

LOC. ENG. ____% SUPTCE. ____%
ACCTG. EXP. ____% INTEREST ____%
ENGINEERING ____%

AUDITED BY
DATE
APPROVED BY
DATE

FORM-B

RECAPITULATION CONSTRUCTION PROJECTS

Project Number	Material	Labor	Insurance	Transp.		Unidist. Charges	Total

	Loc. Eng.	Acc. Exp.		Eng.	Supt.		Int.	Total
Und. Chgs.								

proper space at the lower right on line 14, and the expenses of removing it are placed in the proper spaces at the upper right on lines 1, 2, 3, 4 and 6.

The undistributed charges must now be computed and added to the new construction totals. This is done in the following manner: A composite per centum is determined to cover all indirect charges such as Local Engineering, Accounting Expense, Engineering, Superintendence and Interest Charges. This composite per centum is applied against the total of each account shown on the job order recapitulation on line 6 and inserted on line 7. Lines 6 and 7 are then added to arrive at the total expense of the project during the month which is shown on line 9. The separate per centums covered by the composite per centum are listed at the lower left of the job order recapitulation, so that if occasion should ever arise to use these separately on this single project, it would be a simple matter. Such cases are, however, extremely rare.

Next, the projects are listed on recapitulation sheet (See Form B), showing for each project the material, labor, insurance, transportation, undistributed charges and total expenditure. When this recapitulation has been totaled, the amount of undistributed charges is spread back to Local Engineering, Accounting Expense, Engineering, Superintendence and Interest in order to make the proper credit entries to these various Expense Clearing Accounts. These projects are now placed loosely in cardboard jackets and filed numerically in a drawer labeled "Construction in Progress." From this file or "ledger" may be prepared an analysis of construction in progress, and an Authorized Expenditures Report. The use of this file as a ledger has two distinct advantages. First, it concentrates attention on the data in the job order itself, which makes for greater accuracy. And secondly, it eliminates the unnecessary duty of writing up all the information shown on the estimate in a ledger which is hereby supplanted.

In the succeeding month when expenses are incurred on projects started during the previous month, they are handled in the same manner as described above on the job order recapitulation (Form A), except that the expenditures of the previous month are inserted on line 10, headed "Prior Expenditures," and are added to the amounts shown on line 9, so that on line 11 at all times may be seen the total expenditures on the project to date. These job order recapitulations are then filed in the cardboard jackets in the drawer labeled "Construction in Progress," filing the latest expenditures first in the jackets so that up-to-date information for reports may be readily available at all times.

Up to this point we have dealt with projects in progress. The next duty is to classify the projects under the various Fixed Capital accounts. At the end of each three months, that is, at March 31, June 30, September 30 and December 31, the estimates covering projects completed during the three months' period are signed by the superintendent and given to the accountant. The accountant then removes the cardboard jackets containing the completed projects from the file of Construction in Progress. A combined job order recapitulation is prepared for each project by combining the job order recapitulations for each month during which expenditures on the project were made. These expenditures are then compared with the amount shown on the estimate and the project is thoroughly audited for accuracy in computation and distribution by accounts. These completed projects are then sorted first by town and then by project number and are then written up on a large recapitulation sheet (Form C) from the total expenditures by account that are shown on the final job order recapitulation sheet (Form A). They are then totaled by town and account number to show the total addition to each town by account. These totals are then brought forward to a grand recapitulation sheet (Form D) which when totaled gives a unified summary of property additions by class during the period.

The accounting for retirements is similar to that for additions. The property removed, as shown on the salvage tickets, is listed in a column provided on the estimate for retirements. Adjustments are made for any differences be-

FORM - C

PROJECTS COMPLETED AND CLASSIFIED QUARTER ENDED MARCH 31 1933											
ACCOUNTS	TOTAL	331	332	335	336	337	338	339	342	344A	344D
PROJ. NO.					ARKOMA						
1502											
1547											
TOTAL											
					BOKOSHE						
1513											
1528											
TOTAL											

FORM - D

GRAND RECAPITULATION PROJECTS COMPLETED AND CLASSIFIED QUARTER ENDED MARCH 31 1933											
	TOTAL	331	332	335	336	337	338	339	342	344A	344D
ARKOMA											
BOKOSHE											
BOYNTON											
CHECOTAH											

tween the estimate of units of property to be retired and the units of property actually removed, using the unit cost of the original installation as a basis. These amounts are now inserted on line 12 of the final job order recapitulation and are subtracted from line 11 to show that the net additions by account on line 13. The items shown on line 12 (the retirements) are now written up on Forms C and D in the manner outlined for construction additions.

Next, the value of salvage removed, shown on line 16, and the expense of removing it, shown on line 11 on the right-hand side of the final job order recapitulation (Form A), are listed on Form C.

A journal entry is then made to remove these classified projects from the "Construction in Progress" control account and to set them up in their proper Fixed Capital accounts. In making the journal entry both for additions and retirements, only one posting is made to each Fixed Capital account and only one total posting to each town affected. The salvage and the retirement expense are also removed from "Construction in Progress" by applying them against the proper reserves.

The jobs containing the signed, approved copy of the installation estimate and removal estimate and final job order recapitulation are now bound in the cardboard jacket, stamped with the date they were classified and filed numerically with all the other completed projects in the "Completed Projects" file.

The system that has been outlined satisfies all the needs of the utility, as well as the requests of the regulatory bodies with one exception—a statement of investment in each town by classification at the close of each fiscal year. To compile this statement the grand recapitulation sheets (Form D) are combined, including any miscellaneous entries which failed to travel through the customary channels. This statement is made for both additions and retirements and proved by account with the construction statement for the year. These figures are entered in a special section of the Construction Ledger which provides two sheets for each town, one for additions and one for retirements. Separate sheets are provided in the transmission sections for the major substations and line sections of the transmission system. Each page provides a column for the entries for the year and a column in which may be shown a figure to date. In this manner then, with a minimum of time, the detail accounts for each town are built up year by year. And so, from the standpoint of information required by both utility and regulatory body for rate-making purposes and comparative earnings efficiency statements, this procedure is both simple and adequate.

There is, however, another imporant factor in Fixed Capital accounting which has possibly received too little attention in the past—the ease with which the original cost of a certain portion of property may be identified for retirement or abandonment. There is, perhaps, not a utility in the nation which has not, more or less frequently, experienced some difficulty in ascertaining the original cost of a portion of property to be retired. Here is a condition which, with a little additional effort now, can earn several times the labor spent on it in future years. The system most generally used—that of inserting on the map or atlas sheet the reference to the project by which property has been added or diminished—has been only partially successful for two reasons. First, because of the rapid and numerous changes and rearrangements which occur in densely populated areas, especially in flush seasons; and secondly, because the engineering atlases and maps do not anticipate all of the requirements made on the accountant for information of this nature. The discontinuance of showing such information on the atlas sheet is not advisable, because in many instances property can thus be identified. But a supplement to the atlas, kept by the accountant, is invaluable from the standpoint of time conserved. This supplement is in book form and is kept in town order. In the case of a large town, the area is divided, and, likewise, the transmission system is blocked off, again maintaining separate records of major substations and line sections. Under each town is listed the project number of new construction, date, concise description and the exact location of all additions. On a separate page is listed the same information for all retirements. Then, when a certain portion of property must be retired it is a simple matter to refer to this record to find the project number covering its installation. To keep such a record up to date requires only a few hours' time four times a year, but it will pay for itself many times over fifteen years hence.

Balance Sheet

A comparative balance sheet, showing by accounts, in the first column the condition at the current month, in the second column the changes over the previous month and in the third column the change over the same month of the previous year is very comprehensive. Deferred accounts, either assets or liabilities, should be discouraged insofar as is practicable. The order of accounts and their grouping, if made uniform, would be of material assistance in the preparation of comparisons or in combinations for comparisons with governmental activities. Below are listed in sequence the major accounts suggested for a standardized Balance Sheet:

ASSETS

1. Fixed Capital
2. Current Assets
   - (a) Cash
   - (b) Notes Receivable
   - (c) Accounts Receivable

(d) Interest and Dividends Receivable
(e) Marketable Securities
(f) Material and Supplies
(g) Prepaid Accounts
(h) Subscribers to Capital Stock
(i) Miscellaneous Current Assets

3. Miscellaneous Assets
(a) Investments in Affiliated Companies
(b) Sinking Funds
(c) Replacement Funds
(d) Special Deposits
(e) Deposits in lieu of Mortgaged Property
(f) Miscellaneous Investments

4. Suspense Accounts
(a) Unamortized Debt Discount and Expense
(b) Property Abandoned
(c) Clearing Accounts
(d) Preliminary Surveys and Special Projects
(e) Miscellaneous Suspense

5. Adjustment Accounts
(a) Reacquired Securities
(b) Treasury Securities
(c) Profit and Loss—Deficit

LIABILITIES

1. Capital Stock
2. Premium on Capital Stock
3. Capital Stock Subscribed
4. Proprietor's Account
5. Long Term Debt
6. Receiver's Certificates
7. Current Liabilities
(a) Notes Payable
(b) Accounts Payable
(c) Consumers' Deposits
(d) Matured Interest Unpaid
(e) Dividends Declared
(f) Matured Long Term Debt Unpaid
(g) Miscellaneous Current Liabilities

8. Accrued Liabilities
(a) Taxes Accrued
(b) Interest Accrued
(c) Miscellaneous Accrued Liabilities
(d) Advances from Affiliated Companies

9. Reserves
(a) Retirement Reserve
(b) Unamortized Premium on Debt
(c) Sinking Fund Reserves
(d) Contributions for Extensions
(e) Contingency Reserve
(f) Miscellaneous Reserves
(g) Miscellaneous Unadjusted Credits
(h) Profit and Loss—Surplus

Earnings and Expense Statement

The advantages of establishing a uniform preparation of the Earnings and Expense Statement are so obvious as to require no comment. The order and detail in which they should be shown shall, therefore, be the principal consideration at this time. This statement when prepared to embrace six periods—i.e.: (1) current month this year; (2) same month last year; (3)to date current year; (4) to date previous year; (5) year ended current month; and (6) year ended same month last year, presents a fund of invaluable information. Although a standardized form may be impractical, it is urgent that the results be both comparable and comprehensive. Therefore, the standardized order of an earnings and expense statement is offered below:

1. Gross Earnings—classified as to Residential, Rural, Commercial, Industrial, Street Lighting, Municipal and any additional classes of sufficient local magnitude.
2. Summary of Expenses—classified as Operating, Maintenance and Taxes.
3. Net Earnings.

The summary of expenses is supported by the condensation of detailed accounts which follow in logical order and are subdivided as to Operating and Maintenance and further divided as local conditions demand:

A Production Expenses (showing current generated)
B Transmission Expense
C Distribution Expense
D Utilization Expense (inspections and street lighting expense)
E Commercial Expense
F New Business Expense
G General Expense
H Taxes

Standard Method of Presentation of Essential Facts to Public

There are various methods of presenting to the public comparisons of economy in private and governmental electrical operations, depending, chiefly, on local conditions. There are, however, two important factors which should be included in every such comparison: (1) taxes, and (2) general or administrative expenses.

It has been officially claimed that the TVA pays the same taxes as the private utilities in the Tennessee Valley area. This is actually far from the fact. In truth, the TVA taxes represent only 5 per cent of their gross earnings as against 15 per cent of gross paid by the private utility. The difference between the two must, therefore, be considered in the comparison of both rates and unit costs of operation and generation. Similarly, inasmuch as the engineering and administrative expense furnished the TVA by the Federal Government (and paid in the annual tax bill) are not charged to the TVA, and since the government has made no attempt to allocate the value of such expense, it would be only fair to assume that they are at least equal to those of the private utility. In preparing a comparative expense statement of the two, the additional tax item and actual private general expense should be added to the government reports in order to present an accurate picture of the situation.

In like manner, the TVA average charge per kilowatt-hour must be proportionately adjusted to present a bona fide comparison.

There are numerous other items which should find a place in such a comparative analysis as an adjustment of Federal reports. Some of these are as follows:

1. The TVA has not paid, and does not intend to pay all of the taxes which were levied against it. This would, of course, increase the adjustment for taxes.
2. Their New Business expense should be adjusted by the value of franking service granted in all advertisement, the free printing of their literature and the subsidy appropriated for the sale of electrical appliances. These expenses are borne by the taxpayer but not allocated as expense to the TVA.
3. The difference between the rates of interest in government bonds and rates necessary to fund private companies is an important item. It would seem plausible that the government should pay interest at the rates which private capital must offer for funding purposes.
4. The patent office is open to the TVA so that it may use any of the inventions and improvements for which private companies have spent millions of dollars—(a proper charge to Research and Testing).
5. Considerable adjustment of TVA expenses should be made for depreciation of property. Since the TVA assumed Muscle Shoals at 50 per cent depreciation over a period of nine years (a rate not allowed by Federal courts for electrical generating properties), they have surely recognized depreciation as a legitimate and important expense item in the operation of an electrical utility.
6. A discussion of the TVA rates is a subject for a separate discussion. It is important, nevertheless, to realize that these rates are, in most instances, not only too low inasmuch as the revenue will not for years to come (and, perhaps, never) pay the expenses, but that the absurdly low rates for one classification coupled with the surcharge on others presents a fundamentally unsound economic situation.

There are many other concessions and privileges extended to Federal operations for which the private company must pay hard cash. All such items, perhaps variant with the locality, must be included in comparative statements. It has been proved many times, in the face of statements to the contrary, that energy can be produced more cheaply by steam in most localities than by water power with its huge investment. *The "yardstick" which was milled by the Federal Government will have to be marked off and calibrated by the electrical utility accountant if it is to be of any value to either group concerned.*

Conclusion

The accountant of the electrical utility has been invested with a twofold

(Continued on page 336)

Passamaquoddy—Engineering Possibility; Economic Folly

Latest New Deal power project breaks all records in getting the least electricity for the money—40,000 kilowatts of firm power at $1,000 per kilowatt

By Wm. M. Carpenter

Economist, Edison Electric Institute

(Because of the many requests for information on this nebulous but much publicized project, the following outline of the major engineering features has been prepared. The author is frankly unable to predict the political implications. To do business in Maine, certain enabling legislation must be secured, but the proposed act creating the Passamaquoddy Authority and giving it the right of eminent domain over what many persons concluded was life and liberty itself failed to pass the state legislature. The immediate future is in the lap of the gods.—ED.)

THE Bay of Fundy is a long, island-studded inlet of the North Atlantic, separating the Canadian Province of New Brunswick from its sister Province of Nova Scotia. Through its funnel-shaped mouth sweep the tides from the open ocean, gathering momentum until at the head of the bay they have been known to reach a height of 62 ft. Off its western shore opens Passamaquoddy Bay, a magnificent sheet of deep water, receiving the waters of the St. Croix River and forming part of the boundary between New Brunswick and the State of Maine. Here at the most eastern point of the United States lies the little town of Eastport, with Cobscook Bay opening to the west and Campobello Island, beloved of summer vacationists, immediately across a narrow strait to the east.

For years the great rise and fall of the ocean has intrigued its visitors with dreams of inexhaustible power, and for years Dexter P. Cooper has contemplated a vast project, embracing both the American and Canadian portions, to utilize these tides in a scheme to develop electricity. A Canadian charter was granted on June 15, 1926 (Chap. 23) which provided that active construction should start within three years and be completed within six years. Application to the Federal Power Commission was also made in 1926 and a preliminary permit was issued on May 28, 1926 (No. 463) for a period of three years. On Sept. 14, 1925, the voters of Maine approved a charter for Dexter P. Cooper, Inc., which contained permission to transmit power out of the State of Maine in spite of the provisions of the Furnald Law prohibiting power exports, but included, it is said, the further proviso that no power from this project should be competitively sold in territories already occupied within the state.

Fundy, however, teems with fish. Fisheries give rise to the livelihood of most of its permanent residents, and the project split, among other things, on the doubts of the Canadians as to the future behavior of the humble herring under the new regime of locks, dams and turbines.

The original Canadian charter expired and it became evident that if anything more were to be undertaken it must be confined to the United States.

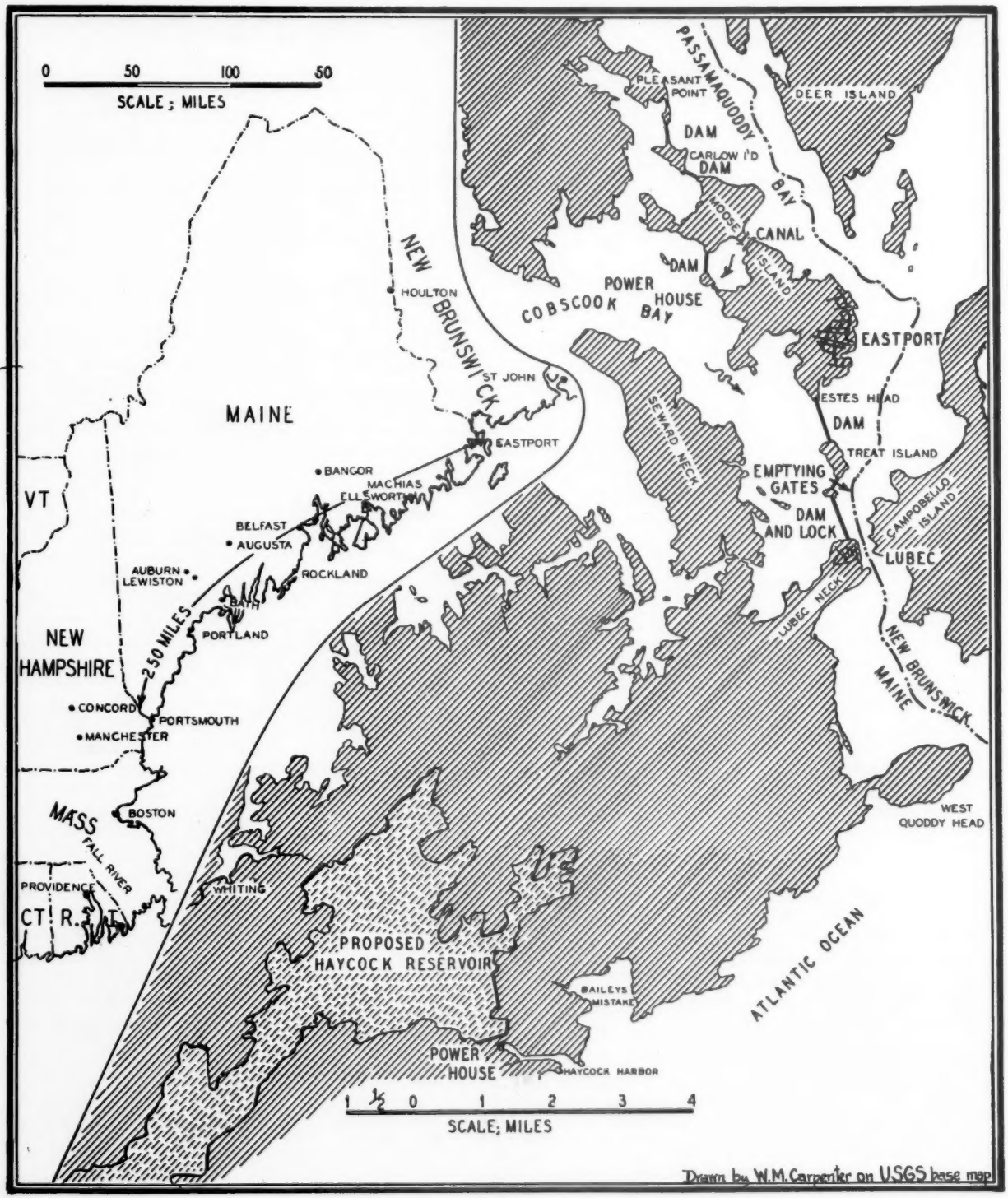
It is not possible to discuss the physical details of the original project. Engineering literature is singularly barren on the whole subject of all the projects. Indeed, recent plans have been so vague as to draw from the *Engineering News-Record* the following observations, contained in an editorial of May 23, 1935:

"Since the Passamaquoddy power project was first put before the PWA for financing about a year ago, details of the proposed project have been kept from the public. Even now, after an allotment of $10,000,000 to start work on an undertaking estimated to cost over $36,000,000 has been recommended to the President, the only drawing that is available is a map showing the location of the proposed dams and power houses. Two inferences might be drawn from this secretiveness concerning the engineering details of the proposed structures, either that they have not been worked out in detail or else that they show all too clearly that the project cannot be built for anything like the estimated cost. If the former is the case, the statement that the work can start in five days is ridiculous; if the latter, the country is being deliberately deceived into putting vast sums into a scheme whose economic justification is questionable."

In the modifications necessary to confine the project to the State of Maine it is probable that considerable sacrifices must have been made and it becomes increasingly evident that the exigencies of geography and the physical behavior of the ocean have imposed limitations which render the worth of the present undertaking—from an economic point of view—highly doubtful.

The large map shows the present tentative layout. Dams are to connect the islands and shut off Passamaquoddy from Cobscook. When the tide rises in the outer bay it will be discharged through turbines into Cobscook. At low tide, gates are opened and Cobscook discharges back into the ocean. With the relatively low head (as hydroelectric plants go) it is evident that huge volumes of water must be moved during short periods of time and that gates of very considerable size must be arranged for. Coupled with the fact that the depth of the water between some of the islands is well over 100 feet in many places where the present tides run like millraces in each direction twice a day, the construction of these works will present engineering problems of the first magnitude. That, however, is not the present concern of this summary. Such obstacles are no worse than many that have been solved all the world over with conspicuous success. The real problem is the behavior of the water itself and the unreliability of the ocean in furnishing the continuous, 24-hour service which modern consumers have come to demand of their electricity supply.

Chart 1 shows one theoretical tide. The degree of filling of the inner basin of Cobscook Bay is conjectural and is shown for purposes of illustration only. It is usually assumed that the turbines cannot run on a head of less than 5 ft. and if this so, then the behavior of the water permits the operation of the plant for about 7½ hours on each tide, after



THE PASSAMAQUODDY PROJECT

Showing Tentative Position of Locks, Dams and Power Houses as Contemplated at Present

which about 5 hours must elapse before the head builds up again.

Such a situation cannot yield continuous power, and to remedy this it is proposed to build a second powerhouse at Haycock Harbor, some 12 miles to the southwest, and to furnish the water for this powerhouse by pumping the ocean up 130 ft. into an artificial reservoir on the hill above. The map shows part of the proposed Haycock Reservoir, whose construction involves many dikes and auxiliary dams and which, alone, is an undertaking of considerable magnitude. The water will be let downhill again to furnish power when the main plant at tidewater is idle.

As far as can be ascertained, between 125,000 and 150,000 kw are proposed for the tidewater plant and 40,000 kw to 45,000 kw at Haycock. Obviously, a considerable part of the power generated at tidewater must be devoted to pumping water into Haycock and the *firm power* of the whole project is the capacity of the Haycock plant.

Some further observations on the project are of interest. Tides are erratic things. They are influenced by wind, weather and, above all, by the almanac. Chart 2 shows the range of the tide at Eastport for the month of August, 1935, as given by the tide tables of the U. S. Coast and Geodetic Survey, and the relation of these ranges to the phases of the moon. It will be noted that they run from a minimum of about 13 ft. at the first and third quarters to a maximum of 24½ ft. about full moon. This is a

(Continued on page 336)

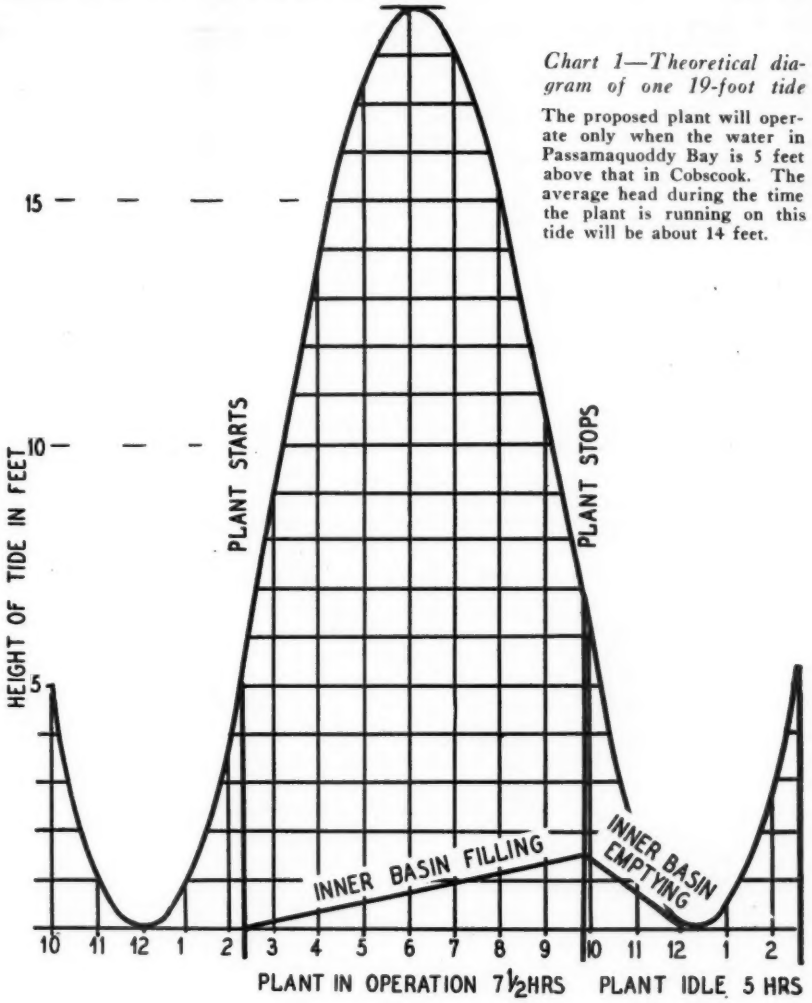
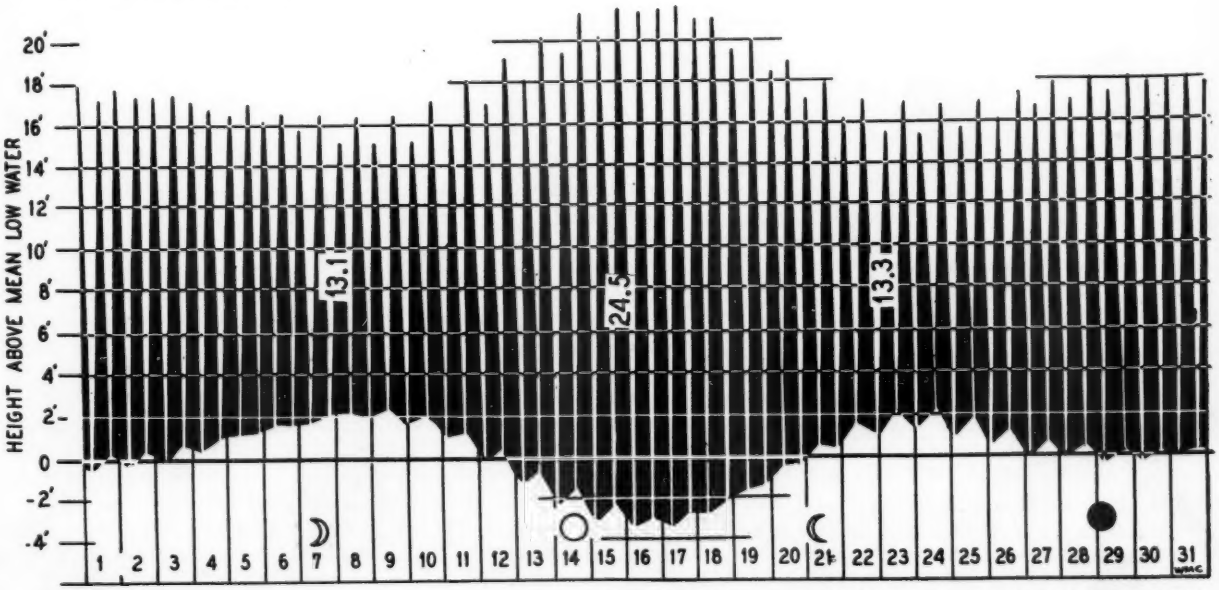


Chart 1—Theoretical diagram of one 19-foot tide

The proposed plant will operate only when the water in Passamaquoddy Bay is 5 feet above that in Cobscook. The average head during the time the plant is running on this tide will be about 14 feet.



(Chart drafted from data in Tide Tables of the U. S. Coast & Geodetic Survey)

Chart 2—Range of tides at Eastport during the month of August, 1935

STATISTICAL DATA OF THE ELECTRIC LIGHT AND POWER INDUSTRY

Compiled Monthly by the Edison Electric Institute—Covers 100% of the Industry

DURING THE MONTH OF JUNE—PRELIMINARY

	1935	1934	%
Kilowatt-hours Generated* (net)			
By Fuel	4,173,597,000	4,494,132,000	− 7.1
By Water Power	3,118,393,000	2,441,973,000	+27.7
Total Kilowatt-hours Generated	7,291,990,000	6,936,105,000	+ 5.1
Additions to Supply			
Energy Purchased from Other Sources	193,740,000	192,382,000	+ 0.7
Net International Imports	73,680,000	83,953,000	−12.2
Total	267,420,000	276,335,000	− 3.2
Deductions from Supply			
Energy Used in Electric Railway Departments	41,409,000	47,546,000	−12.9
Energy Used in Electric and Other Departments	113,827,000	108,778,000	+ 4.6
Total	155,236,000	156,324,000	− 0.7
Total Energy for Distribution	**7,404,174,000**	**7,056,116,000**	**+ 4.9**
Energy Lost in Transmission, Distribution, etc.	**1,256,804,000**	**1,173,922,000**	**+ 7.1**
Kilowatt-hours Sold to Ultimate Consumers	**6,147,370,000**	**5,882,194,000**	**+ 4.5**
Sales to Ultimate Consumers (kw-hrs)			
Domestic Service	1,059,338,000	972,929,000	+ 8.9
Commercial—Small Light and Power (Retail)	1,094,729,000	1,049,281,000	+ 4.3
Commercial—Large Light and Power (Wholesale)	3,395,842,000	3,273,239,000	+ 3.7
Municipal Street Lighting	152,435,000	143,849,000	+ 6.0
Railroads—Street and Interurban	331,473,000	337,942,000	− 1.9
Railroads—Electrified Steam	65,022,000	54,847,000	+18.6
Municipal and Miscellaneous	48,531,000	50,107,000	− 3.1
Total Sales to Ultimate Consumers	6,147,370,000	5,882,194,000	+ 4.5
Total Revenue from Ultimate Consumers	$151,436,900	$147,337,000	+ 2.8

DURING TWELVE MONTHS ENDING JUNE 30th

Kilowatt-hours Generated* (net)			
By Fuel	52,981,067,000	52,064,368,000	+ 1.8
By Water Power	34,109,595,000	30,900,269,000	+10.4
Total Kilowatt-hours Generated	87,090,662,000	82,964,637,000	+ 5.0
Purchased Energy (net)	2,867,609,000	3,374,271,000	−15.0
Energy Used in Electric Railway and Other Departments	1,973,343,000	1,972,816,000	+ 0.0
Total Energy for Distribution	**87,984,928,000**	**84,366,092,000**	**+ 4.3**
Energy Lost in Transmission, Distribution, etc.	**15,055,789,000**	**14,603,893,000**	**+ 3.1**
Kilowatt-hours Sold to Ultimate Consumers	**72,929,139,000**	**69,762,199,000**	**+ 4.5**
Total Revenue from Ultimate Consumers	**$1,874,423,400**	**$1,805,625,500**	**+ 3.8**
Important Factors			
Percent of Energy Generated by Waterpower	39.2%	37.2%	
Average Pounds of Coal per Kilowatt-hour	1.44#	1.45#	
Domestic Service (Residential Use)			
Average Annual Consumption per Customer (kw-hr)	648	614	+ 5.5
Average Revenue per kw-hr (Cents)	5.20¢	5.39¢	− 3.7
Average Monthly Bill per Domestic Customer	$2.81	$2.76	+ 1.8

BASIC INFORMATION AS OF JUNE 30th

Generating Capacity (kw)—Steam	23,731,860	23,927,400	
—Waterpower	8,950,319	9,006,500	
—Internal Combustion	501,364	470,400	
Total Generating Capacity in Kilowatts	33,183,543	33,404,300	
Number of Customers			
Farms in Eastern Area (Included with Domestic)	**(542,000)	(512,329)	
Farms in Western Area (Included with Commercial—Large)	**(213,000)	(209,407)	
Domestic Service	20,677,152	20,252,244	
Commercial—Small Light and Power	3,747,876	3,710,149	
Commercial—Large Light and Power	505,135	527,432	
Other Ultimate Consumers	69,905	66,405	
Total Ultimate Consumers	25,000,068	24,556,230	

* By courtesy of the U. S. Geological Survey with deductions for certain plants not considered Electric Light and Power Enterprises.

** Preliminary data. Final figures will be issued by states.

Data for month of May, 1935, appears inside of front cover.

Does It Pay?

By C. E. Greenwood

Commercial Director, Edison Electric Institute

THE question of economic importance in the promotion of Electric Water Systems has been raised in more than one company, and has been an influence in determining whether or not to tie in with the Running Water Program of the Electric Water Systems Council. The final concentration started on August 1 and there is a supply of Broadsides ready for those companies that will participate.

This is an opportune time to give a moment's review to the rural situation. For a score of years, more aggressively the last 12, the utility companies have been planning and building that electricity might become helpful to the farmer. Hundreds of millions of dollars have been invested in rural lines and facilities but only 10 per cent of the farms are so termed "electrified." In many of these farms electricity is not being used to the economic advantage of the farmer, and for no reason of failure of utility effort. When electricity is at the farmer's service the load building process is just beginning. The farmer may buy lightning rods from high pressure salesmen but he ponders over changes in his method of doing farm labor. Our Commercial Executives know too well that rural electrification is not sold easily. It is first an educational problem; it is specifically economic, and it has its social aspects.

The farmer's wife is often entirely forgotten by friend husband in the modernizing feature until she listens to a radio broadcast—perhaps from the local utility—or visits her favorite son or daughter who is enjoying the new-fangled methods of doing housework, and then she begins to assert her rights. The appeal of more comfortable and higher-plane living vibrates in her own being. But still the farmer has no electricity.

Starting with the assumption that "Barkis is willin'," the rural dweller is faced with some of the same drags that have faced his urban relatives such as cost of wiring, cost of equipment to do the many jobs on the farm and farmstead, and choice of equipment and easy financing if there is ability to pay at all. These are aside from the problem of the utility in obtaining during the past few years the capital required for extensions.

From all sides the problem seems to be "Money, money, who's got the money?" if the people who want electricity haven't. And the answer is, "Uncle Sam." He saw the Directors of one of his great electrical development projects wincing under the obstacles that had stymied the private utilities in electrifying the homes of the nation and organized the Electric Home and Farm Authority. TVA officials learned that home owners and tenants must spend substantial amounts to purchase equipment which will use enough electricity to *earn* the rate that they have determined the masses can pay. "But you can't get blood out of a stone," which might be translated that you can't have home owners in TVA territory, much less tenants, invest $300 in electrical equipment when they only see over the year approximately $300 in hard money, and when the amount involved may be one-third to one-quarter of the value of the home itself.

While it is being decided whether five years or eight or ten years is too long to make the purchase of electrical equipment a minimum hardship, another link in the government chain of uneconomic undertaking has been forged to aid the rural consumer, namely, the Rural Electrification Administration. There is confronting the Directors of this electrical development scheme every economic obstacle that confronts load building in the urban communities, and then some. So Uncle Sam must come to the rescue again. Private business has no inexhaustible supply of wealth. If private business taxes in the form of higher prices people do not buy. Uncle Sam taxes and the people pay.

Now although the utility may resent with righteous justification any invasion of its business, it always vigorously pushes forward under conditions imposed upon it. Our southern utilities are going the limit to do the best job possible in TVA territory. Achievements are matters of record.

And just so with the Rural Electrification Administration. Whatever can be done that is economically sound—or shall we say is not economic suicide for private interests—will be done. Scores of utilities want the farmer to enjoy the benefits of electricity as much, and probably more than he may desire himself.

Through a Special Committee of utility representatives, an offer has been made to undertake a rural electrification program totaling approximately $238,000,000. That is, if the government undertakes the expenditure of this amount on the highway, the utilities will cooperate with an expenditure of 40 per cent to 50 per cent on private extensions. The cost of new lines, meters and transformers will benefit approximately 350,000 rural prospects at an estimated cost of $1,356 per mile. The report of the Special Committee is a result of several months of study and investigation.

Even if Uncle Sam spent money for these rural extensions there is still the educational job for the utilities to do. They should and will continue to sell the electrical idea to the farmer.

The density of consumers will be a determining factor in the action taken on line extensions. Rate for service must be somewhere in keeping with possible income. The four to five customers per mile lines are already built.

The farmer can be sold first on light. The safety factor as compared with the lanterns in the barn and all the troubles incident to upkeep are well known sales appeals to the farmer's wife and entire family. Light for brooders, for hen houses and ultra violet application is as important as light for utility. It is estimated that the average farm has 33 lighting outlets in the buildings and yards. The average wattage is around 700.

After lighting, of greatest appeal to the farmer and the farmer's wife is running water. It has been estimated that the average annual requirement of the farm is approximately 150,000 gallons of water per year. Although the electrical energy used may be only 1.2 kilowatt hours per thousand gallons, it is easy to realize the social advantages gained, and the contribution to better living through this small expenditure of the farmer's funds. If there is higher-

plane living on the farm, attention will be directed just naturally to electrical equipment which in the household forms the stepping stones from drudgery to more comfortable and healthful living.

The Electric Water Systems Council was formed 18 months ago when P. H. Powers, Chairman of the Rural Sales Committee, and his associates sensed the need of sales concentration on some one valuable service to the rural consumer, in order to establish a nucleus around which to build greater rural activity. Jointly with a far-sighted group of pump manufacturers, a promotional program was prepared which closes in December. Special Broadsides prepared at minimum cost will be found most effective in sales appeal.

Now the Director of Rural Electrification Administration has picked the electric water system as a piece of equipment meriting major attention. It has previously been made possible for loans to be made through Federal Housing Administration to people in rural and semi-rural communities for drilling a wall and installing an electric water system. Now REA encourages running water service. It will pay the utility to join in the promotional parade. Many leading companies are already lined up in this cooperative movement. In encouraging and directly aiding electrical consumers to install a water system the utility is making a contribution to human welfare which cannot be measured alone in kilowatt hours used. The running water activity has the advantage of being a cooperative movement with pump manufacturers and dealers locally, and will give the consumer a valuable service at low cost. It pays.

Commercial Managers!

Order now Broadsides prepared by Electric Water Systems Council for Fall Concentration-Running Water Program.

Cover your market for Electric Water Systems.

Lots 1,000—$20.50 per thousand
Over 1,000— 19.50 per thousand

EDISON ELECTRIC INSTITUTE
420 Lexington Ave.
New York City

Chairman H. P. J. Steinmetz has called a meeting of the Sales Committee at The Greenbrier, White Sulphur Springs, Va., on September 17th, a day in advance of the Sales Managers Association of AEIC.

INDUSTRIAL HEATING POINTERS

Control and Safety Demands Electric Heat

GENERAL PLASTICS, INC., North Tonawanda, has developed a new phenol product which requires distillation of a volatile and highly inflammable liquid. In addition, accurate temperature control at the distillation temperature is essential. Their problem has been solved by the construction of a distillation tank in which 108 kw of electric immersion units are installed. Thermostatic control maintains the accurate temperature demanded. This installation consumes approximately 450,000 kwhr per year.—*C. P. Yoder, Buffalo, Niagara & Eastern Pr. Corp., Buffalo, N. Y.*

Heat Treating Department Modernizes

TO reduce costs and improve the quality of the dies used in the manufacture of their product, Spaulding Fibre Company, Tonawanda, is modernizing its heat treating department. Antiquated fuel-fired equipment is being replaced with modern electric furnaces. The installation consists of a 7.5 kw, C. I. Hayes, Certain Curtain furnace for hardening high-speed steel and a 10 kw Certain Curtain furnace for preheating high-speed steel and heat treating carbon tool steel.—*C. P. Yoder.*

An Encouraging Sign of Business Improvement

TO meet the production requirements of increased business, Barcalo Mfg. Company of Buffalo has installed an additional 136 kw box type electric oven for baking japan finish on bed springs. It is estimated this oven will consume 480,000 kwhr per year.

Electric heat is no innovation to this company. Other ovens and heat treating furnaces account for 230 kw of previously installed electric heating load.—*C. P. Yoder.*

High Quality Maintained With Electric Heat

THE Diamond Saw and Stamping Company, Buffalo, has long been famous for quality hack saw blades. To maintain this quality in their current line of high-speed steel blades, a modern fuel-fired furnace was installed about a year ago. This was purchased principally on the basis of low first cost. The furnace, however, failed to meet the requirements. This experience graphically illustrates the fallacy of attempting to buy on price where quality is involved. After this sad experience they are now turning to electric heat. The blades will now be hardened in a C. I. Hayes, Certain Curtain, 12 kw furnace and tempered in a 10 kw box type furnace.—*C. P. Yoder.*

Yes, Modernization Pays

A ONE HUNDRED AND SIXTY kw atmosphere controlled, conveyor type electric furnace made by Electric Furnace Co. has recently been installed at the Buffalo Bolt Company, North Tonawanda, for hardening high quality bolts. This work had previously been done in a 190 kw rotary hearth electric furnace. At the time of its installation the rotary hearth furnace was the last word in furnace design. It has, however, been unable to keep pace with the exacting requirements now demanded by bolt purchasers. In addition to a smooth surface, no oxidation is permitted on the teeth of the threads. The atmosphere control of the new furnace has entirely eliminated surface oxidation, the production capacity has been increased over 75 per cent and the electrical capacity reduced by 30 kw. That's modernization at its best.—*C. P. Yoder.*

Electric Heat for Precision Work

CONTINUING their efforts to produce drills, reamers, and special tools as nearly perfect as possible, the Ampco Twist Drill Company has installed a Hayes Certain Curtain electric hardening furnace for temperatures around 2375° F., and a Leeds & Northrup electric drawing furnace for the production of their products. This equipment automatically controlled within 5° plus or minus will not only increase efficiency in tempering and in the quality of the drills, but will also enable them to hold tolerances of .0001 of an inch.

The total load of the furnaces is 80 kw, operating at 240 volts. It is believed some credit for this installation is due to the continuous activity on the merits of electric heat during the past six years. — *F. B. Adams, Consumers Power Company, Jackson, Mich.*

Proposed Revision of the National Electric Code

By Alexander Maxwell

Director of Engineering, Edison Electric Institute

IN THE December, 1934, issue of the EDISON ELECTRIC INSTITUTE BULLETIN the relation of the National Electrical Code to the electrical industry was discussed. This article showed, among other things, how the editorial form of the code and the nature of its provisions affected the development of the electric light and power industry.

As a result of active discussions among those concerned with this code for interior wiring, comprising, among others, the Fire Insurance Underwriters, the Electrical Inspectors, the Electrical Manufacturers and the Electric Light and Power Industry, it was determined to undertake a general revision of the code. These discussions culminated in definite action by the Electrical Committee of the National Fire Protection Association, the joint committee which has the custody of this code and its periodical revision, and which is also qualified as a "Sectional Committee" of the American Standards Association, as such being competent to formulate and revise standards for approval as "American Standards" according to the procedure of the latter organization. This Electrical Committee, in March, 1935, ordered that a general revision of the code should be prepared for future consideration by the industry and the Electrical Committee; a drafting subcommittee was set up to do this.

Previous to this, during the autumn of 1934, the Electric Light and Power Group, representing the utility industry, had printed and circulated widely among the interested groups a proposed form of a revised code which incorporated the ideas discussed in the article of December, 1934. The principles illustrated in the proposed revision received considerable favorable comment from most branches of the electrical industry itself, although at the same time the various inspectors' organizations showed apprehension lest their special uses for the code might be lost sight of—a wholly groundless apprehension so far as the intent of the authors was concerned.

During the summer considerable progress has been made by the drafting subcommittee toward an appraisal of the problem before them. So far as information is available, it appears that the principal difficulty that is being encountered in the revision is the one referred to above—namely, a preoccupation with the aspect of the code as an inspectors' document at the expense of due consideration of its importance as an industry standard.

The proposal originally advanced by the Electric Light and Power Group was that the code should be separated into two parts, the first being that containing fundamental technical considerations which would establish, as an industry standard and on engineering grounds, what materials and practices could or could not be used; while the second part would contain the details of application that are particularly useful to the inspector in the field in determining whether installations are actually made in accordance with requirements or not. This idea, of a two-part code, did not find much favor outside of the Electric Light and Power Group, although the reasons for opposition to it are not entirely clear. The same result could, of course, be accomplished by two entirely separate and distinct codes, one of which might constitute the industry standard and establish the engineering principles upon which interior wiring should be installed, while the second code might be purely an inspectors' manual of application. There is a good deal of merit in such a proposal because one of the main difficulties in procuring engineering treatment of new proposals in the code has been the difficulty of expressing them in terms of the details of application suitable for use by inspectors; but this would be still further from the views of those who objected to a single code in two distinct parts.

The proposal that found the most favor and upon which the drafting committee is now working, is that the basis or engineering requirements should be incorporated in a series of principal rules governing the fundamentals of wiring, and that the details of application should follow these, each in its own group. This plan is entirely feasible, although it appears to require a high degree of skill in draftsmanship and thereby to increase rather than decrease the difficulties of drafting a revised code suitable for its modern responsibilities.

Probably the real difficulty back of these divergent views is a fundamental difference in the way in which the various groups regard the code as an entity. Broadly, it may be said that the difference in viewpoint is between a static and a dynamic code. Those who desire a high degree of detail and the expression of all the code requirements in terms suitable for use in the field appear to be those who believe or hope that interior wiring may be regarded as a completed and static art wherein important changes no longer need be expected. If this concept were true, there would be a good deal of merit in this position, because if the materials and methods of wiring were definitely established there would be little to do beyond describing the requirements for application in the field to avoid shoddy workmanship, etc. On the other hand, if it is conceived that wiring is not a finished art and that there are possibilities, and even pressing necessity, for substantial improvement in materials or methods, two requirements are indispensable for a smoothly working code. The first of these is that the basic engineering requirements that would apply to any conceivable kind of wiring should be plainly exhibited in order that new developments may conform to them in advance. The second is that the form of the code should be hospitable to hitherto unseen developments, so that they can be quickly and easily incorporated into its text.

There is good reason to hope that many groups besides the electrical utilities are now persuaded of the necessity for new developments in wiring to meet modern economic conditions, especially the conditions affecting the large numbers of consumers now being drawn from low income groups. It is not so certain, however, that others have thought as far ahead as has the electrical utility group into the problems of administration and field application that are involved in an art that is subject to technical regulation but at the same time is changing rapidly. It has appeared to the electrical utility group that since it is substantially conceded that some form of technical regulation by means of the code is necessary or desirable for the wiring art, the code itself should be skillfully designed to fulfill this purpose.

Meeting of the Joint Subcommittee on Development and Research

THE Spring meeting of the Joint Subcommittee on Development and Research with its Project Committees was held in the General Office of the Edison Electric Institute on June 7th, with Mr. Silver, the E.E.I. chairman, presiding. Progress reports covering the activities of the last six months were presented by each of the nine Project Committees. These Project Committees deal with various aspects of noise frequency and low frequency induction and structural coordination problems. In addition to the Progress Reports a total of six Technical Reports were presented.

Project 1B, Noise Evaluation, presented Technical Report 1B-6 entitled, "Relative Interfering Effects of Different Single Frequency Noises in Telephone Circuits." The information contained in this report is essential in many noise frequency induction studies. The values which have been generally used in the past were based on tests conducted in 1914 and 1918. Since that time, a large amount of additional work has been done on the subject of relative interfering effects. In view of developments in the art, attention has also been directed to the upper part of the noise frequency band which was not covered in the earlier tests. The report presents the revised values for the relative interfering effects of different frequencies of noise on a telephone circuit. The tests on which these values were based are described, as are also tests made to determine how adequate these values are for estimating the relative interfering effects of several representative types of circuit noise. Comparisons are made between the revised values and those which have been generally used in the estimation of noise. The Project Committee recommended this report for issuance as an Engineering Report.

Project 2A, Hazard and Protection, presented for the information of the Joint D & R Subcommittee, Technical Report 2A-10 entitled "Study of 26-Kv Joint Use in New Jersey." This report describes a study of the safety problems involved in the joint use of poles by 26-kv transmission lines and aerial exchange cables. The power and telephone systems involved are described, and estimated fault currents and potentials resulting from contact are given. Certain features of the power system and the telephone system which affect safety are discussed in detail.

Project 2D, Specific Devices, presented Technical Report 2D-13 entitled, "Low Resistance Grounds." This report presents information on the installation and measurement of low resistance grounds obtained from various sources. The usefulness of different kinds of electrodes employed in the construction of these grounds is discussed together with the matter of chemical treatment of the soil to reduce its resistance. A discussion of the general classification of soils suited for low resistance is included as well as the methods used in determining the best locations for the installation of the electrodes. The physical features of construction are taken up and the proper spacing of electrodes is described. The effect of time on the resistance of grounds is shown, bringing out the extent of seasonal variations. The impedance of grounds at high frequencies based on a limited amount of data is discussed and the last part of the report deals with methods of measuring ground resistance. The Project Committee recommended that this report be issued as an Engineering Report.

Project 2J, Control of Residuals, presented Technical Report 2J-7 entitled "Study of Observations From Low-Frequency Inductive Exposures." This report presents an analysis of data relative to low-frequency induction due to power system ground fault currents, obtained from oscillographic observations and related records from 28 inductive exposures. Data as to the magnitude and magnitude distribution of observed voltages and their comparison with estimated values are presented, together with available data as to the effects of such voltages. Where possible, statistical methods have been used in analyzing the data so as to provide means whereby the effects of factors subject to fortuitous variation may be included in estimates of induced voltages. The results of the study are intended as an aid in the appraisal of other inductive coordination problems.

Project 2K, Coupling Coefficients, presented for the information of the Joint D & R Subcommittee, Technical Report 2K-4 entitled, "Application of Finite Line Formulas to the Computation of Coupling Between Ground-Return Circuits." The practical aspects of the application of formulas for the mutual impedance of circuits of finite length to the computation of coupling between ground-return circuits is presented, particularly with respect to irregular exposures. Comparisons are made of the process, accuracy and times required for computations by the finite line method and by the infinite line method, the latter being given in Engineering Report No. 14. For purposes of study and illustration, both methods were employed in the computation of the coupling in a particular irregular exposure possessing features common to a great number of cases. The inaccuracy inherent in the result, due to inaccuracies in the given physical parameters, leads to a limitation of the necessary accuracy of any method. It is concluded that for the majority of exposures the increased accuracy at 60 cycles afforded by the method of finite lines is unwarranted when the amount of time required to work up the results by this method is considered. However, based on Foster's finite line formulas means are worked out for correcting the results of infinite line computations to take account of end effects and prominent uncompensated discontinuities within an exposure. In angular exposures of few sections, and in the analysis of measurements of test sections and probe wires lie the greatest opportunities for practical use of the finite line method.

The Bell System representatives of *Project 2K* presented for the information of the Joint D & R Subcommittee Special Technical Report 21 entitled "Correlation of Geological Structure and Effective Earth Resistivities at Low Frequencies." Data on the correlation of effective earth resistivity and geological structure at a large number of points in the United States are presented in this report. The resistivity data have been obtained from mutual impedance measurements, largely at fundamental power system frequencies. Information has been obtained from geological literature on the structure of the earth at each of the various test sites. It is

(Continued on page 333)

Cooperation is Keynote in Rectifier Supply Coordination

By F. E. Sanford and V. G. Rettig

Electric Distribution Department, Union Gas & Electric Company, Cincinnati, Ohio

A report of telephone interference investigation and remedial measures by: Union Gas & Electric Company, Cincinnati & Suburban Bell Telephone Company, Crosley Radio Corp. in connection with installation of rectifier for 500,000 watt broadcast transmitter of Crosley Radio Corp.

THE supply of power to the world's largest broadcasting station, installed at Cincinnati by the Crosley Radio Corporation, produced a somewhat complicated harmonic analysis problem. Plate supply for the 500,000-watt transmitter is provided by a six-phase (three-phase, full wave) mercury vapor rectifier delivering a normal output of 100 amperes at 12,000 volts. This rectifier, together with the auxiliaries of the WLW transmitter, and the WSAI and W8XAL transmitters, has a power demand of 1500 kw. The new transmitter was placed in service in May, 1934, after four months of midnight to morning experimental operation.

Early in the discussion of this installation, the Cincinnati and Suburban Bell Telephone Company and the American Telephone and Telegraph Company called the attention of the Crosley Radio Corporation and the Union Gas & Electric Company to the possibility of telephone interference from the power transmission lines supplying the radio station, and distribution lines supplied by the same transmission lines, where these lines parallel telephone circuits. Preliminary calculations made by the Bell System engineers and by the Edison Electric Institute General Office engineers, indicated that there would be a considerable wave-shape distortion on the power supply lines, due to the rectifier load at the broadcast station.

Due to the complexity of the associated transmission system and other factors involved, it was recognized that accurate calculations could not be made that would permit the design of corrective measures or equipment. Moreover, it was not entirely agreed that the increased influence would be of an objectionable order. Following the preliminary calculations, it was, therefore, agreed that the installation should be completed and that tests should be made with the new equipment in service before further consideration of remedial measures. These tests were made during the experimental operation period, and checked fairly closely the basic figures of the preliminary calculations.

Based on the test results, several filter designs were made and a filter has been installed and is in operation with satisfactory results. While the fundamental knowledge of rectifier supply wave-shape analysis is not greatly increased by these tests and this installation, there are a number of practical considerations that are of importance. In addition, many of the methods of calculation and formulas developed in previous wave-shape studies of the Joint Development and Research Committee of the Bell System and E.E.I. (and former N.E.L.A.), were given a trial which confirmed their accuracy.

Several points of practical consideration may be of value and interest from the power supply utility standpoint.

1. Power supply to a large rectifier of any present design is likely to increase the odd non-triple harmonics on the power supply system, and should be given due consideration in the supply and equipment layout.

2. This increase of wave-shape distortion may or may not cause an objectionable interference with parallel communication circuits. Calculations by present known methods and formulas are sufficient to indicate the possibility and probable magnitude of wave-shape distortion and approximate severity of telephone interference.

3. On any power supply system of comparable complexity to this one, a complete pre-determination of characteristics with a resultant accurate design of corrective measures, probably is not advisable.

4. Although both the calculations and the tests may indicate a definite distortion of wave-shape, the actual telephone interference resulting, because it is a function of susceptibility and coupling as well as this influence, may not be serious or may be economically remedied by local corrective measures where it occurs.

5. Other means of overcoming any interference difficulties that may arise should be given careful study, along with consideration of a filter. This involves the extent and characteristics of both telephone and power facilities, and future development of the plants.

6. A filter, if decided upon, should be installed adjacent to the rectifier equipment and should be considered as a part of the rectifier customer's installation of equipment. Careful consideration should be given to the filter design, to the end that it will accomplish the necessary improvement at a cost consistent with over-all economy.

In the Cincinnati case, the majority of tests were made by the Telephone Company, with assistance from the Power Company and the rectifier customer, each company paying its own expenses. The filter was purchased by the rectifier customer and installed as a part of their equipment. The Power Company engineers cooperated with the Telephone Company and rectifier customer's engineers to the fullest extent possible, in the preliminary consideration and calculations, in the tests made, and in the negotiations and filter installation which followed.

Description of Rectifier

The main rectifier of the 500,000-watt WLW transmitter employs a new type tube developed by the General Electric Company, designated RCA 870. They are hot cathode mercury vapor type and six tubes are used. High level Class B modulation is used in the transmitter and the load varies with modulation or loudness of the program. The plate supply load rises at syllabic frequencies to as high as 50 per cent over minimum value.

The rectifier circuit is essentially a three-phase full wave arrangement. Three single-phase plate transformers are used and the primaries may be switched to either delta or wye connection. For normal full load operation, the primaries of these transformers are connected delta.

Power Supply System

The main transformer bank at Crosley station is rated 2000 kva 33,000-2300 volts 4.7 per cent impedance, and is con-

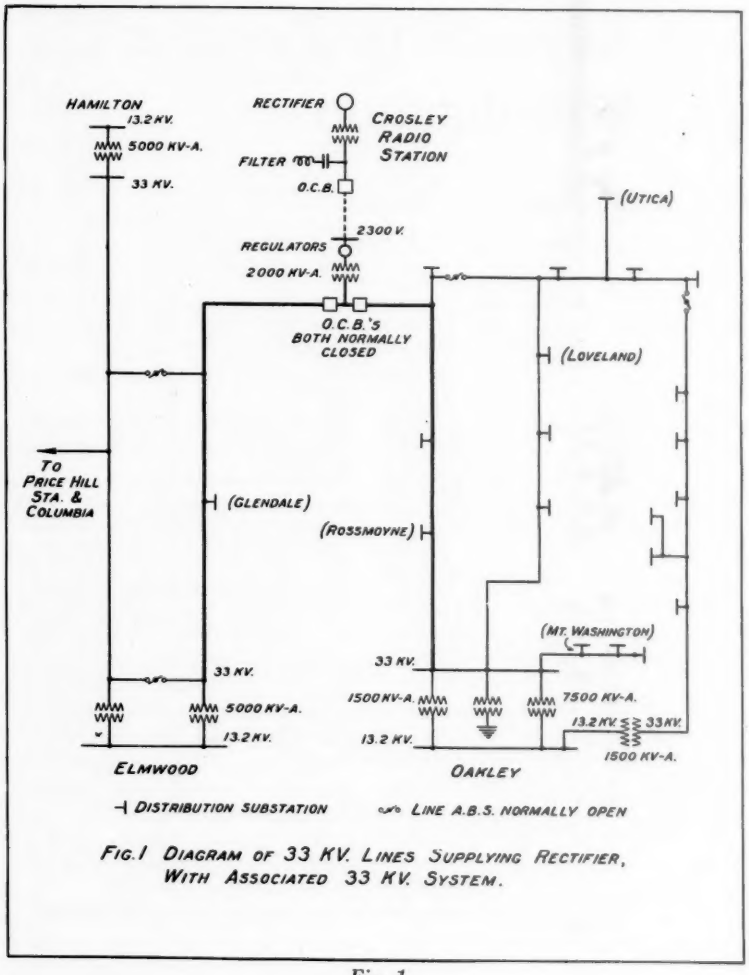


FIG. 1 DIAGRAM OF 33 KV. LINES SUPPLYING RECTIFIER, WITH ASSOCIATED 33 KV. SYSTEM.

Fig. 1

nected delta-delta. Two 62.5 kv-a 2300 volt induction regulators maintain 2300 volts on the bus. Part of the auxiliary equipment of the station is supplied directly from the 2300 volt bus and part through 2300-230/460 volt transformers.

The Crosley Radio transmitter is located about twenty-five miles North of downtown Cincinnati. It is supplied by two 33 kv transmission lines looped through automatically operated oil circuit breakers which are opened on power reversal due to line faults, leaving the station supplied by the other circuit. Automatic reclosing of the opened switch is provided through synchro-verifier relays, as soon as voltage is restored to its associated line.

One of the 33 kv circuits is supplied from Elmwood substation, near the northern limits of Cincinnati, and is about 19 miles long. The other line is from Oakley substation, in the northeastern part of Cincinnati, and is about 17 miles long. Elmwood and Oakley substations are each supplied by 66 kv transmission lines from Columbia power plant and by 13.2 kv underground transmission cables from West End power plant. The 33 kv circuits run over widely separated rights-of-way and enter the Crosley station from opposite directions.

From the 33 kv buses in both substations, other transmission lines are supplied. The main bus in each substation is 13.2 kv and from them transmission lines are supplied, as well as distribution transformer banks for the 4 kv distribution system. As noted later, there was very little feed-back at harmonic frequency beyond the 33 kv bus in the two substations, and practically no distortion on the 13.2 kv system or on the 4 kv system from these two substations. Due to the presence of resonance conditions, however, the distortion at other points of the 33 kv system exceeded the values at the Crosley station.

Figure 1 shows the main transmission connections and the adjoining system. The 33 kv system is delta connected, the only ground being through a grounding bank at Oakley substation. The two lines supplying Crosley station, as well as the associated 33 kv lines, supply local distribution substations. The transformer banks in these stations are delta-wye connected and the distribution feeders are operated 2400/4150 volt, four-wire, with neutral grounded at the substation source.

In addition to the 36 miles of 33 kv line directly connected to the Crosley station bus, there is approximately 70 miles of line connected to the Oakley 33 kv bus during normal operation. An additional 85 miles of line may be connected to the Oakley and Elmwood buses during emergency operation. There are 4 distribution substations supplied by the two lines to Crosley station and 10 more supplied at 33 kv from Oakley. These figures indicate the magnitude of the power supply system that would have been involved in any coordination plan.

Telephone System Exposure

All of the telephone circuits which parallel the transmission and distribution lines involved in this case, are at road separation, except a few exposures on joint construction with 4 kv distribution circuits. There are 9 central office exchanges of the telephone system which have subscriber line exposures. Three general classes of central offices are involved: (1) magneto office employing bridged ringers; (2) magneto office employing grounded ringers for party line circuits; and (3) common battery office employing grounded ringers for party line circuits.

A large part of the exposed telephone system is for rural service with open wire multi-party lines, using either metallic or grounded ringer subsets. There is practically no joint use with open wire, road separation being the general condition encountered. A considerable mileage of toll and trunk circuits parallel the 33 kv transmission lines. The trunk circuits are mostly in cable, while toll circuits are principally open wire, both being at road separation.

Tests on Power & Telephone Circuits

The Telephone Company and the Bell Laboratories furnished complete equipment for the tests, both on the power supply system and on the telephone circuits. Mr. H. E. Kent of the Edison Electric Institute, and engineers of the U. G. & E. Co assisted in making the

tests, which covered a period of several weeks. Operation of the rectifier associated with the 500,000-watt transmitter caused an increase in the voltage Telephone Interference Factor (TIF) at the 33 kv Crosley station bus from 32 to 111 with normal power feed to the Crosley station. As a result, the voltage TIF on the 4 kv distribution system supplied from the 33 kv lines was increased from a range of 27-52 to a range of 69-140. Increases of the same order of magnitude were observed in the products of current times current TIF (IT) for the 33 kv circuits. Table 1 shows the principal values and also the corresponding values after the filter was installed.

TABLE I—VOLTAGE T I F

Transmitter	50 kw	500 kw Without Filter	500 kw With Filter
Crosley station	32	111	37
Glendale	34	78	26
Elmwood (13.2 kv.)	12	16	12
Rossmoyne	28	74	23
Oakley (13.2 kv)	15	33	15
Utica	52	140	32
Loveland	31	92	31
Mt. Washington	31	78	29

A harmonic analysis of the power system voltages and currents showed that in most cases the harmonics controlling the TIF were the 11th, 13th, 17th, 19th, and to some extent the 23rd (660, 780, 1020, 1140 and 1380 cycles). Some effect was also noted from the 7th (420 cycle) harmonic, but this was important only on one section of the Elmwood transmission line.

The number of telephone toll and trunk circuits on which noise reached objectionable levels with the 500,000-watt transmitter in operation was relatively small. Subscribers circuit noise level was of greater importance in the consideration. Practically all of the circuits where the noise level became objectionably high were at exposures to the 33 kv transmission lines. The test included only two locations where the increase in noise was greater than about 3 to 1 and in most cases it was of the order of 2 to 1. At the two locations, the increase was 4 to 1, but a redesign of transpositions of the open wire lowered one of them. In only a few instances were the noise levels high where the telephone circuits were carried in cable.

From the test results obtained, it appeared technically feasible, in most cases, to obtain a good degree of coordination in this situation by use of carefully coordinated telephone circuit transpositions and higher impedance ringers in party line subscriber sets. But it was recognized that this would be somewhat complicated due to the many and extensive exposures, and that a high degree of maintenance would be necessary.

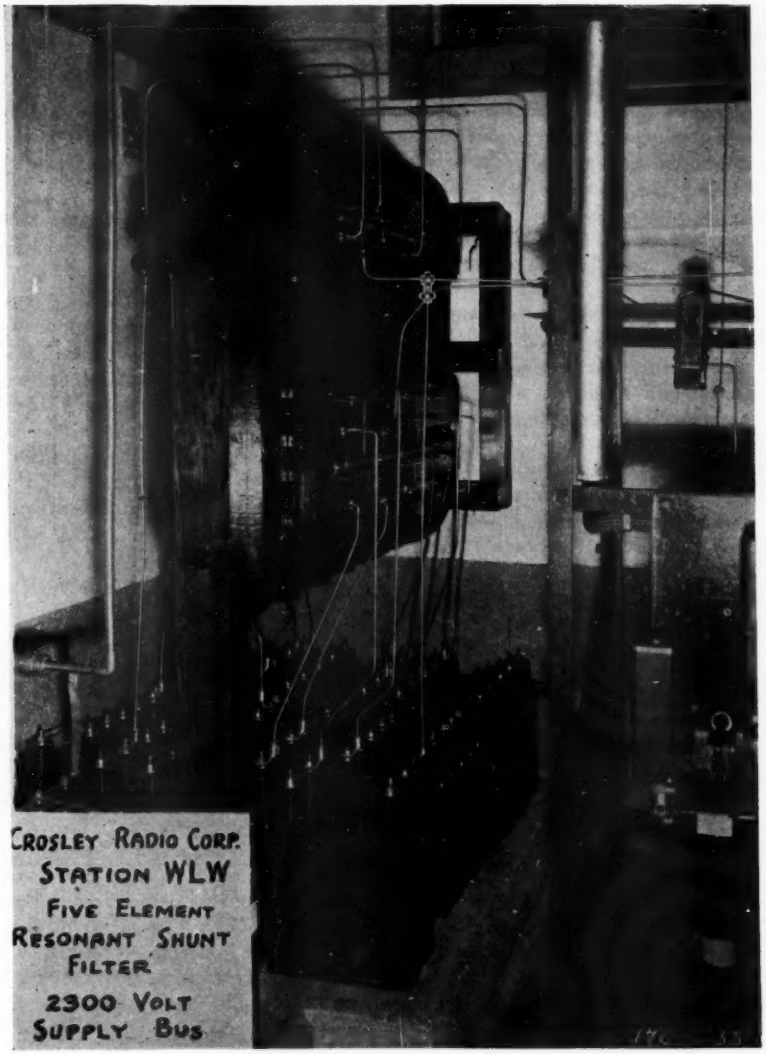


Fig. 2

Consideration In Design of Filter

As might be expected, there was considerable variation possible in the design values of the filter proposed, depending on the corrective effect desired. The basis for corrective measures was largely a result of negotiation and consideration of the particular circumstances surrounding the case.

The basis of the preliminary filter design proposed by the Bell System engineers was that the interference could be reduced to values comparable with the average values for this type of transmission circuit observed in a national wave-shape survey. The average values of voltage TIF and IT products for transmission circuits in the voltage range of 19 to 44 kv as determined in such a survey, are 20 and 1610, respectively.

Previous to the installation of the 500,000-watt transmitter, WLW was operated for several years at 50,000 watts, and was supplied by the line from Oakley only. With this load and supply, the voltage TIF at Crosley station was estimated to have been somewhat over 32, as compared to the 111 value at the station with the larger transmitter in operation. The basis of design then proposed was that the interference should be reduced to about the same level with the 500,000-watt transmitter operating that it had been in the past with the 50,000-watt transmitter.

It was further noted from the test results, that the necessity for a filter unit for 420 cycles was questionable. This frequency was relatively important in in-

terference only on a few exposures to the Elmwood line. Tests indicated that a satisfactory reduction in noise level could be obtained by changing some subscriber subsets equipped with grounded low impedance type ringers, which are very susceptible to the lower frequencies, to high impedance type ringers. The cost of a 420-cycle unit of the filter was relatively high, as compared to the other frequencies.

Four designs of filters were considered under these general conditions. These filters consist of air core inductance coils and standard condenser units, designed for connection, phase to phase, to the 2300 volt bus at the Crosley station. Each inductance is carefully adjusted for resonance with the capacitance. A comparison of the filters is shown by the values of capacity (in microfarads) required for each phase, in Table II. The total capacity required for each frequency is three times these values.

TABLE II

Frequency	420	660	780	1020	1140	1380
First design*..	5.0	10.0	7.5	7.5	15.0	5.0
Second design..	10.0	10.0	10.0	7.5	7.5	5.0
Third design**	12.5	12.5	7.5	5.0	5.0	5.0
Final design..	none	10.0	5.0	5.0	5.0	3.0

*First design also included a series reactance in the load circuit.
**Third design provided for omitting the 420 cycle unit.

The voltage requirements of the transmitter amplifier system made it undesirable to include series reactance in the main supply circuit. For this reason, the first design was not seriously considered. The second design would have given a voltage TIF of 21, as proposed by the Telephone Company. The third design would have given a voltage TIF of 31, with the 420-cycle unit omitted. The final design, as proposed by the Crosley Radio Company, was designed by the U. G. & E. Co engineers to give a voltage TIF of 34 at Crosley station. This design was accepted by the Telephone Company and the final agreement reached on this basis. The complete design of the filter is shown in Table III.

TABLE III

Values for Resonant Shunts Connected Phase to Phase

F	Microfarads C	Millihenries L	Filter Harmonic Current	Calculated Effectiveness
660	10	5.83	9.8	4.8
780	5	8.34	7.3	3.5
1020	5	4.85	4.9	5.3
1140	5	3.89	4.0	7.8
1380	3	4.45	2.8	3.8

The calculated effectiveness is the ratio of harmonic voltage or current on the Crosley bus with no filter to the voltage or current with the filter operating. Experience with this filter installation indicates the importance of careful specification of reactance and resistance of the units. The ratio of reactance of the coils to the resistance of their respective shunts at their resonant frequencies (commonly designated as Q) was specified to be 40. It is very desirable that the resistance of coils and condensers be low if the maximum effectiveness is to be obtained. It should be noted that condensers that have a resistance of ¼ of 1 per cent of the reactance at 60 cycles have a per cent resistance to reactance of several times this value at the harmonic frequency, with a correspondingly low value of Q.

After the installation of the filter, tests indicated that its effectiveness at the higher frequencies was much less than the estimated values. This was due to the type of condensers, and the coupling between coils with the method of mounting used, as supplied by the manufacturer. After the condensers were replaced by units having the values of reactance to resistance ratio specified, the calculated effectiveness was approximated. The final test results showed that the reduction in the harmonics for which the shunts were installed was somewhat greater than calculated, but that this was offset by an increase of the 300 and 420-cycle components that was somewhat greater than estimated.

The voltage TIF at the Crosley station bus was within a small per cent of the previously calculated value. Largely due to the increase in the 420-cycle wave, the IT values were greater than had been calculated. The controlling frequency in the voltage TIF and the IT values as well as in the induced telephone circuit noise is now the 420 cycle, whereas before the installation of the filter, a larger proportion was contributed by the higher harmonic frequencies. Because the subscribers' circuits with low impedance grounded ringers are very susceptible to longitudinal induction at this frequency, the noise in these circuits was found to be somewhat higher than anticipated.

The noise in most of the telephone circuits checked after the filter installation was found to be reduced to about the same level as before the 500,000-watt transmitter was placed in operation. In general, the reduction in noise level brought about by the filter installation was considered entirely satisfactory.

RECENT E.E.I. PUBLICATIONS

BOILERS, ECONOMIZERS, AIR HEATERS AND PIPING

E.E.I. Pub. C-4. A report of the Prime Movers Committee, Edison Electric Institute, 31 pages. Price 60¢ to members and their employees; $1.50 to non-members in the U.S.A.; $1.60 to foreign countries.

Summary of the report:

Leakage and tube starvation in boilers, and deficient steam temperatures and tube failures in superheaters have required the use of corrective measures, which have usually been successful. Water wall and economizer operation has been satisfactory, but considerable trouble with air preheaters has been reported. The use of steam washers in boiler drums has, in one case, reduced turbine deposits.

The behavior of metals at high temperatures and detailed information concerning welding of piping are covered.

Proper precautionary measures must be taken in laying up boilers to prevent corrosion.

Boiler availability for high pressure units compares favorably with, or exceeds, the turbine availability.

In foreign boiler developments, the use of unconventional designs is still prevalent to a marked degree.

Manufacturers' statements include descriptions of recent designs and installations of boilers and auxiliary equipment.

TURBINES, CONDENSERS AND FEEDWATER HEATERS—1935

E.E.I. Pub. C-5. A report of the Prime Movers Committee, Edison Electric Institute, 17 pages. Price 40¢ to members and their employees; $1.00 to non-members in the U.S.A.; $1.10 to foreign countries.

This report contains statements by operating companies and manufacturers on:

Turbine Operating Experiences.

Deposits on Turbine Blading.

Corrosion and Erosion of Turbine Blading.

Turbine Lubricating Oil.

Test of 90,000 kw Turbine-Generator.

Condenser Operating Experiences.

Condenser Tube Materials.

Chlorination of Circulating Water.

Circulating, Condensate, and Boiler Feed Pumps.

Feedwater Heaters and Deaeration.

Present Status of Maximum Allowable Motor Starting Current

REQUESTS from manufacturers of motor-driven equipment for information on definite rules for applying motor-starting devices are frequently received by the Edison Electric Institute. The following review of the subject sets forth briefly the reasons why the Institute cannot furnish specific information. The discussion relates primarily to alternating current motors.

At the present time there are no specific motor-starting current regulations sponsored by the industry as a whole, although each individual company has such regulations, differing as required by local conditions. A set of recommendations were published by the National Electric Light Association in 1923 and were adopted in whole or in part by some of the operating companies. These recommendations related permissible starting current to motor size and bore little relation to the ability of the electric system to absorb the starting current without objectionable voltage drop. Companies using these rules found that objectionable voltage fluctuation resulted in many installations, while in many other cases unnecessary starting equipment was installed.

It is obvious that, except for special applications involving numerous intermittent starts, across the line starting of a 50-horsepower motor in a factory with a 1000-horsepower total demand would have no effect whatever on the service supplying the factory regardless of its starting current. On the other hand, starting a 2-horsepower motor connected at the end of a long secondary or a 10-horsepower motor on a long rural line might result in very serious voltage disturbance, not only to the service of the owner of the motor, but also to other services fed from the same circuit.

The 1923 rules, never universally accepted, have gradually been discarded by an increasing number of companies as being unsuitable for present conditions. In 1934, the Electrical Equipment Committee of the E.E.I. rescinded them as industry recommendations.

Experience since 1923 has led to the conclusion that motor-starting current rules, based on the capacity of the system at a given point to render the service, result in much more economical installations for consumers in the large majority of cases, and also prevents uneconomical demands being made upon the utility for excessive starting currents at remote points. In arriving at this, due regard was given to the desirability of being able to provide manufacturers of machinery driven by electric motors with definite information as to when starters would or would not be required, regardless of where the machinery might be installed. Likewise, consideration was given to the feasibility of developing a line of motors which could be used universally without starting devices. A study showed that to obtain this feature too great a sacrifice in the running characteristics and cost of the motors would be required in the vast majority of motor installations.

The Electrical Apparatus Committee of the former N.E.L.A. in 1929 adopted the following general principles for motor starting rules:

"The problem of proper motor starting values is not one for the power companies alone nor the manufacturers alone, nor are their interests basically in conflict. Both groups wish to encourage the maximum use of electricity and such use is most encouraged when electricity is applied to the mechanical task for the lowest possible total cost including:

"1. The cost of the motor and its accessories, and

"2. The cost of the power company in serving that load.

"The size of a motor in proportion to the total load fed by one service has a great bearing on the relative importance of these two factors of cost. For example—the starting current of a 10-hp. motor in a group of motors totaling 1,000-hp. would have no effect whatever on the size, and, therefore, the cost of the service; in this case the manufacturer's cost is of dominating interest. In the other extreme where the motor is practically the total load served, the power companies' facilities must be designed primarily for the starting current and are then easily adequate for running current; therefore, in this case the power company's cost is of dominating interest.

"It is, therefore, apparent that rational starting rules must take into account these conditions. It would then appear that the conditions under which the desired service is to be supplied should govern the permissible starting currents."

Regulations based on capacity to serve have been adopted by a number of the larger companies and they are found to result in less trouble and expense due to voltage flicker, and also on the average more motors have been installed without reduced voltage starters. These regulations usually make provision for larger starting currents where conditions permit. The attitude of one of these companies is expressed in a paper by Mr. H. R. Woodrow which appeared on page 271 of the July, 1935, issue of the EDISON ELECTRIC INSTITUTE BULLETIN.

The present recommended practice involves the establishment of motor-starting regulations for each individual operating company which relate the permissible starting current to the capacity of the electric distribution system to serve the load.

The electric light and power industry is desirous of cooperating fully with motor manufacturers and manufacturers of motor-driven equipment so as to obtain for the customer the most satisfactory and economical installation of equipment using electrical energy. At the present time the only way to accomplish this is to obtain from the local utility the starting current requirements for the individual installations. This can be promptly and readily obtained when the sale of the equipment is being negotiated, and will frequently result in a saving to the customer and an easier sale for the manufacturer.

The history of committee work and actions on this subject is covered thoroughly in an article entitled "Electrical Equipment Committee Rescinds N.E.L.A. Motor Starting Rules," published on page 251 of the July, 1934, issue of the EDISON ELECTRIC INSTITUTE BULLETIN.

Meeting of D. and R. Subcommittee

(Continued from page 328)

shown that there is a more or less consistent relation between the effective resistivity within any particular area and the structure of the earth's crust in that area. The principles underlying this relation are discussed and it is shown that the results of the analysis of the data presented are in general agreement with these principles. Maps and charts are included that will facilitate the prediction of the order of magnitude of effective resistivities in areas where no test data are available.

Announcement will be made in the E.E.I. BULLETIN when reports recommended for issuance as Engineering Reports are approved by the Joint Committee on Plant Coordination.

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B9	The Electric Light and Power Industry in 1933	(10/34)	.30	.75	.85
B10	Electrical Energy Diversion	(10/34)	.20	.50	.55
B11	Cable Operation—1933	(12/34)	.60	1.50	1.60
B12	A-C Network Operation—1932-1933	(12/34)	.40	1.00	1.10
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A5	Power Station Chemistry	(7/33)	.40	1.00	1.10
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A14	Current Carrying Capacity of Impregnated Paper Insulated Cable	(7/33)	.25	.65	.85
A15	Electric Roasting Ovens	(8/33)	.20	.50	.60
A16	Load and Revenue Forecasting	(7/33)	.30	.75	.85
A17	Promotion of Home Air Conditioning	(8/33)	.20	.50	.60
A18	Economic Design of Hydro-Electric Plants	(8/33)	.20	.50	.60
A19	Hydraulic Governors	(8/33)	.20	.50	.60

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The Institute has in stock a limited number of reports prepared by Engineering Committees of the former National Electric Light Association during the past several years. A price list will be forwarded upon request.

POWER SALES ITEMS

AIR CONDITIONING

"The Control of Corrosion in Air Conditioning Equipment by Chemical Methods," by C. M. Sterne. Paper presented at the annual meeting of the ASTM. Ice and Refrigeration, July, 1935, p. 1. Nickerson & Collins Co., 435 N. Waller Avenue, Chicago, Ill., Publishers.

"Industrial Air Conditioning for Comfort," by J. M. Demarest, International Business Machines Corporation. Heating and Ventilating, June, 1935, p. 21. The Industrial Press, 148 Lafayette Street, New York City, Publishers.

"World's Highest Air Conditioning System," by A. B. Wason. Heating, Piping and Air Conditioning, June, 1935, p. 277. Keeney Publishing Company, 1900 Prairie Avenue, Chicago, Ill.

Describes the main offices of the American Cyanamid Company on the 57th floor of the RCA Building, New York.

"The Dust Problem in Air Conditioning," by F. B. Rowley. Heating, Piping and Air Conditioning, June, 1935, p. 277. Keeney Publishing Company, 1900 Prairie Avenue, Chicago, Ill.

"Restaurant Air Conditioning." American Restaurant Magazine, June, 1935, p. 34. Patterson Publishing Company, 5 South Wabash Avenue, Chicago, Ill.

Restaurant owners attribute large increases in business and more efficient operation to air conditioning.

"The Electrical Warming of, and the Supply of Hot Water and Conditioned Air to Large Buildings," by R. Grierson, D. Betts. Journal Institution of Electrical Engineers (British), May, 1935, p. 461. Edited by P. F. Rowell, Savoy Place, Victoria Embankment, London, W C2.

"Air Conditioning Is Ready for 'Main Street,'" by K. C. Porter. Electric Light and Power, May, 1935, p. 32. Bennett-Watts-Haywood Company, 360 North Michigan Avenue, Chicago, Ill., Publishers.

"Air Conditioning a Chocolate Plant," by W. F. Schaphorst. Power Plant Engineering, May, 1935, p. 299. Technical Publishing Company, 53 West Jackson Blvd., Chicago, Ill.

Blumenthal Brothers install three air conditioning units.

"Silicosis: Its Causes and Prevention." Rock Products, May, 1935, p. 40. Tradepress Publishing Corporation, 542 S. Dearborn Street, Chicago, Ill.

Respiratory diseases caused by dust can be prevented by use of modern equipment and air conditioning.

"The Economics of Air Cooling with Steam and with Electricity," by W. P. Rock. Electric Light and Power, April, 1935, p. 26. Bennett - Watts - Haywood Company, 360 North Michigan Avenue, Chicago, Ill., Publishers.

BREWERIES

"Brewery Air Conditioning." Electric Refrigeration News, June 26, 1935, p. 12. Business News Publishing Company, 550 Maccabees Bldg., Detroit, Michigan.

Equipment requirements and advantages for air conditioning in fermenting rooms.

DIESEL ENGINE

"Power Costs Less than ½ Cent at Wm. E. Hooper & Sons' Mill, Baltimore, Md.," by Donald McFee. Diesel Power, July, 1935, p. 451. Business Journals, Inc., 192 Lexington Avenue, New York City, Publishers.

Describes in detail the Diesel generating unit and the power costs for the year 1934.

"Diesel Engine Data." Power, June, 1935, p. 290. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

Operating costs of 156 Diesel plants. Reprint abstracts from ASME Report.

"Looking Dieselward," by E. J. Tangerman. Power, June, 1935, pp. 284-288. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

This article is a general discussion of Diesel engines, their operation and approximate costs. Following this article is a list of Diesel manufacturers, and a condensed copy of the ASME report on Diesel Operating Costs.

"The Country Turns to Diesel." Diesel Power, June, 1935, pp. 350-353. Business Journals, Inc., 192 Lexington Avenue, New York City, Publishers.

This article deals with the number of HP in Diesels that have been installed in various industries. It predicts that the greatest output of Diesels during 1935 will be those of under 100 HP in capacity.

"Legal Municipal Contracts for Purchase of Diesels," by Leo T. Parker, Diesel Power, June, 1935, pp. 356-358. Business Journals, Inc., 192 Lexington Avenue, New York City, Publishers.

This article points out some of the legal difficulties that arise in the sale of Diesel engines by manufacturers to municipalities. Power engineers will be interested in this article as it points out certain things that make it impossible for municipalities to buy Diesel generating equipment.

"Test Engines for Diesel Fuel," by T. B. Rendel. Power Plant Engineering, April, 1935, p. 227. Technical Publishing Company, 53 West Jackson Blvd., Chicago, Ill.

Progress in the art of Diesel fuel testing.

"Double Acting Diesels for Peak Load Service." Power Plant Engineering, April, 1935, p. 224. Technical Publishing Company, 53 West Jackson Blvd., Chicago, Ill.

New Swiss plant with three 7,400 hp. units is the largest in Europe.

ELECTRIC DRIVE

"Progressive Modernization of Electric Drives Pays." Editorial, Electrical World, July 6, 1935, p. 41. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

This editorial points out that recent applications of electric power in industry have proved that there is an extensive field in modernizing American industry. In a recent installation, the following benefits were obtained: Safer and cooler conditions for employees, substantially reduced maintenance costs and provision for securing variable speed operation.

"Electricity in Brewing and Malting," by H. V. Henniker. World Power, June, 1935, p. 289. Publishers, 62 Lincoln's Inn Fields, London, W C2.

ELECTRIC FURNACES

"Electric Enameling Extended." Electrical World, April 27, 1935, pp. 35-36. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

After comparing economies of an electric furnace with those of a fuel fired furnace, a porcelain sign manufacturer installed an additional continuous recuperative type electric furnace.

"Melting Metals Electrically," by George H. Hall. Electrical World, May 11, 1935, pp. 25-27. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

A general description of several types of melting furnaces and their application.

"Electric Furnaces in Industrial Heat Treating," by A. G. Lobley. Heat Treating and Forging, March, 1935, p. 742. Steel Publications, Inc., 108 Smithfield Street, Pittsburgh, Pa., Publishers.

ELECTRIC MOTORS

"Proper, Up-to-date Motoring Pays Its Own Way," by H. M. French. Power, June, 1935, pp. 310-312. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

Proper motoring by substituting new and more efficient motors for old and misapplied motors is one way of relieving power costs.

"Motor Drives in Garment Factory," by Reginald Gordon. Electrical World, April 27, 1935, pp. 36-37. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

In this article Mr. Gordon explains briefly why garment manufacturing affords a large field for the application of small electric motors.

HEATING

"Design, Installation and Operation of an Institutional Heating Plant," by C. J. Eckardt. Heating and Ventilating, May, 1935, p. 43. The Industrial Press, 148 Lafayette Street, New York City, Publishers.

Heating and ventilating requirements at the University of Texas met by wide variety of systems.

"Inductive Heating." Metals & Alloys, April, 1935, p. 85. Chemical Catalog Company, 3619 Forbes Street, Pittsburgh, Pa., Publishers.

High-grade results obtained in heat treatment and paint drying by inductive heat.

Passamaquoddy

(*Continued from page 323*)

variation of nearly 90 per cent. Both the height of high and low water are never the same, and, moreover, because tides are some 20 minutes more than 12 hours apart, high and low water never come at the same time, but each day arrive somewhat later. The filling of the reservoir at "off peak" hours is therefore difficult and there are certain days in each month when Haycock must carry the entire peak.

Estimates for the completed project are conflicting. Forty million dollars appears to be the one most discussed at present. If it costs $40,000,000 (including accumulated interest) to build the whole project and the 40,000 kw at Haycock represents the firm power, then this stands at $1,000 per kw—a world's record for hydroelectric developments. This compares with the $150 which represents the cost of many of Maine's existing waterpowers.

The author hesitates at figuring costs per kwhr. All this is salt water and in a region of a winter climate of considerable severity. What the costs of operation and maintenance of machinery will be under a head of salt water which changes from minute to minute, nobody knows, but it will probably be considerable. If $2,000,000 a year represents the operating expenses and fixed charges on $40,000,000, Haycock power at 60 per cent capacity factor will cost 1 cent per kwhr at the busbar. At the end of a transmission line to the state boundary, 250 miles away, it will cost a lot more. As the detective novels say, all the information for a complete solution has now been presented, and the reader is invited to figure tides, kwhrs and costs himself.

But, perhaps, the Federal Government will follow the precedent set at Muscle Shoals and write off the investment and accrued interest at 30 cents on the dollar, so the reader's guess is as good as the writer's.

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CONVENTIONS AND MEETINGS

SEPTEMBER

3-6 Illuminating Engineering Society, Netherland Plaza Hotel, Cincinnati, Ohio.
4-6 Pennsylvania Electric Association, Bedford Springs, Pa.
9-11 Rocky Mountain Electrical Association, Stanley Hotel, Estes Park, Colo.
17 Sales Committee, The Greenbrier, White Sulphur Springs, W. Va.
18-28 National Electrical and Radio Exposition, Grand Central Palace, New York.
23-25 National Electrical Contractors Association, Chicago, Ill.
23-27 American Transit Association, Atlantic City, N. J.
30 American Institute of Mining & Metallurgical Engineers, Chicago, Ill.

OCTOBER

1-4 American Institute of Mining and Metallurgical Engineers, Chicago, Ill.
4-5 Empire State Gas and Electric Association, Westchester Country Club, Rye, N. Y.
7- 8 Electrical Equipment Committee, Edgewater Beach Hotel, Chicago, Ill.
7-11 National Electrical Manufacturers Association, Chicago, Ill.
9-11 Transmission and Distribution Committee, Edgewater Beach Hotel, Chicago, Ill.
14-17 American Gas Association, Palmer House, Chicago, Ill.
14-18 National Electrical Wholesalers Association, Chicago, Ill.
15-18 National Association of Railroad and Utilities Commissioners, Nashville, Tenn.

JANUARY, 1936

28-31 American Institute of Electrical Engineers, New York, N. Y.

Challenge to the Accountant

(Continued from page 320)

duty which must be disposed of by the concerted effort of every utility company of America. First, he must decide upon, and put into use as quickly as possible a simplified, uniform accounting procedure. As a result of this, he will be enabled to prepare, as a company or as a group of companies, a comprehensive statement of operations and unit costs which he may use as a comparison with any contemplated or actual Federal operation in any locality. Secondly, he must be prepared to reduce government statements to the nationally standardized statements to show a true comparison of economies of operation—this, unless the Federal Government base its own statements on the procedure used by every electrical utility throughout the nation.

And thus, it is obvious that the challenge to the electrical utility accountant of today is the necessity of convincing his company executives and the regulatory bodies as well, that accounting practices must be standardized. The uniform classification of some years ago was a splendid step toward this goal, but it has since become somewhat obsolete. Some agreement must be reached which, although it will undoubtedly necessitate some sacrifice of accounting procedures on the part of each company, will eventually prove invaluable to all of the companies in the years to come.